The Role of Working Memory in Achievement Goal Pursuit

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Statement of Originality

This thesis represents my own original work towards this research degree and contains no material which has been previously submitted for a degree at this University or any other institution, except where due acknowledgement is made.

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Abstract

In the achievement motivation literature (Elliot, 1999), motivational foci are thought to create different perceptual-cognitive frameworks which guide behaviour when in an achievement situation. The goals of mastery-approach (development of self-referential competence) and performance-approach (demonstration of normative competence) have been found to exert different effects on various outcomes. Relatively less research has examined the cognitive processes through which these effects might operate. The current thesis aims to contribute to the motivation-cognition interface by presenting a series of studies designed to examine the role of working memory in experimentally induced mastery-approach and performance-approach goal pursuit.

In study 1, a meta-analysis is presented with the objective of identifying an effective method of manipulating, and conducting manipulation checks of, achievement goals in the current thesis. Results confirm that study design features influence observed achievement goal effects. In study 2, a preliminary investigation of the impact of achievement goals on working memory, across load, was conducted. Under high load, performance-approach goal pursuit resulted in poorer working memory processing than mastery-approach goal pursuit or a no-goal control. In study 3 and 4, dual task methodology was used to measure the working memory resource requirements of achievement goal pursuit. Results show that when working memory is loaded, those pursuing mastery-approach goals experience larger performance decrements than those pursuing performance-approach goals.

Finally in study 5, it was predicted that if achievement goals differentially engage working memory this would reflect in differences in gross measures of performance and task strategies on a category-learning task. These predictions weren't

supported. It was however found that trait goal orientation and self-reported state achievement goals shared distinct patterns of relations to category-learning according to the pattern of predictions outlined for their manipulated equivalents. It is concluded that mastery-approach goal pursuit relies on the availability of working memory more than performance-approach.

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CHAPTER 1

An Introduction

Overview

Sometimes we are motivated to acquire new skills, while other times we are motivated to prove that our skills are better than someone else's. What does it mean, in cognitive terms, to be motivated in such ways? The interplay of motivational states and cognitive processes such as encoding, storage and retrieval of information has attracted substantial research interest (Friedman & Forster, 2001; Graham & Golan, 1991; Weiner & Walker, 1966). Contrasting with some early cognitive approaches that reduced motivation and emotion to information processing (Nisbett & Ross, 1980; Ross, 1977), the distinct role of non-cognitive variables is now demonstrated through thriving research at the motivation-cognition interface (Maddox & Markman, 2010; Revelle, 1993). This research has shown, for instance, how incentive-based states enhance cognitive control (Savine & Braver, 2010), and how appetitive states impact upon attentional focus (Gable & Harmon-Jones, 2008). Various motivational factors have also been found to influence decision making (Trope & Liberman, 2003) and problem solving (Mueller & Dweck, 1998; Winne & Marx, 1989), furthermore illustrating the important connectivity between motivation and cognition. Such findings have contributed much to our understanding of what one motivated individual does cognitively that a differentially motivated individual might do differently. The primary aim of the present thesis is to add to this literature by examining the role of working memory in qualitatively different approach-based motivational states from the achievement motivation literature – specifically, having a goal to develop skill versus to demonstrate skill.

The achievement goal approach (Dweck 1986; Elliot, 1999; Nicholls, 1984) addresses the *reason* for behaviour in achievement settings, including the aims or outcomes associated with the type of goal motivated focus one adopts when in such settings (Elliot, 2005). These motivational foci are thought to create different perceptual-cognitive frameworks i.e., different patterns of cognition and action, which guide behaviour when in an achievement situation (DeShon & Gillespie, 2005; Dweck & Leggett, 1988; Elliot & Dweck, 1998). Two distinct forms of achievement goal foci have dominated the literature; a motivated focus on the development of self-referential competence (i.e., developing skills) is known as a *mastery focus*, whilst a motivated focus on the demonstration of normative competence (i.e., demonstrating skills) is known as a *performance focus*. Although this founding two-factor conceptualisation has dominated the literature, these foci have each been suggested to vary in terms of motivational direction (Elliot, 1999; Elliot & Church 1997; Elliot & McGregor, 2001). That is, one can be motivated to approach (i.e., strive to increase) normative or self-referential competence, or, alternatively, one can be motivated to avoid decrements in these competencies. The present research is designed to focus specifically on the founding dichotomous achievement goal model; on the role of working memory in mastery-approach pursuit and performance-approach pursuit.

Also, many researchers conceptualise these foci as individual differences variables, namely *goal orientations* (VandeWalle, 1997; VandeWalle, Brown, Cron, & Slocum, 1999), whereas others conceptualise them as motivational states, namely *achievement goals*, elicited by particular cues, settings or instructions (e.g., Chen, Gully, Whiteman, & Kilcullen, 2000) (see Elliot, 2005). Research confirms the distinction between these trait and state forms (Chen et al., 2000; Kozlowski, Gully, Brown, Salas, Smith, & Nason, 2001; Ward, Rogers, Byrne, & Materson, 2004). These goal foci can change across achievement tasks (Muis & Edwards, 2009) and combinations of these goal foci can be adopted in an achievement situation (Yeo, Sorbello, Koy & Smillie, 2008). State achievement goal effects have been examined in various settings including the laboratory (Kozlowski et al., 2001), classroom (Church, Elliot, & Gable, 2001), sports field (Bernier & Fournier, 2010), and workplace (Martocchio, 1994), with manipulation methodology used to induce these goals varying much between studies. Such methods include the use of feedback frames (Chen & Mathieu, 2008; Steele-Johnson, Perlow, & Pieper, 1993), aim or goal target frames (Poortvliet, Janssen, Van Yperen, & Van de Vliert, 2007; Van Yperen, Elliot, & Anseel, 2009), perceptions of ability (Steele-Johnson, Beauregard, Hoover, & Schmidt, 2000), and standards of evaluation or grading systems (Church et al., 2001; Harackiewicz, Manderlink, & Sansone, 1984), for example. Chapter 2 will explore achievement goal manipulation methodology in more detail. The present research is specifically concerned with the relationship of state achievement goals to working memory. Thus overall, the present research interest lies in the role of working memory in state mastery-approach and state performance-approach goal pursuit.

Much research has found that achievement goals exert different effects on various outcomes including persistence, actual achievement and problem solving for example (see Kaplan & Maehr, 2007). Meta-analytic findings suggest mastery-approach to be more efficacious than performance-approach and that the benefit of eliciting mastery-approach is larger when tasks are complex (high cognitive demand) relative to when tasks are simple (e.g., rote learning) (Utman, 1997). However, relatively less research has specifically examined the cognitive processes through which these effects might operate. This is somewhat surprising given that the competence related purpose with which one approaches a task has much potential to influence cognitive processes engaged on a task. Research has typically focused on the relations of achievement goals (both measured and experimentally manipulated) to questionnaire assessments of cognitive and metacognitive strategy use (e.g., Bell & Kozlowski, 2008; Elliot, McGregor, & Gable, 1999; Meece, Blumenfeld, & Hoyle, 1988; Wolters, 2004). Results indicate that strategies such as monitoring, elaboration and planning, are more characteristic of mastery-approach than performance-approach. Other research has found superior maintenance of categorisation strategies in recall tasks (Escribe & Huet, 2005), increased likelihood of problem solving strategy transfer (Bereby-Meyer & Kaplan, 2005) improved comprehension and synthesis of information (Gist & Stevens, 1998) and better use of effective task strategies on complex cognitive scheduling tasks (Winters & Latham, 1996) for mastery-approach relative to performance-approach. Interestingly, high scores on cognitive scheduling tasks for performance-approach has also been found, but typically only under less demanding task conditions (Mangos & Steele-Johnson, 2001; Steele-Johnson et al., 2000). Overall, these studies are the exceptions to a relative paucity of research examining cognitive processes that are elicited by, or concomitant with, these achievement goal foci.

One limited storage system under attention control involved in the maintenance and manipulation of goal-relevant information is working memory (Baddeley, 2002; Baddeley & Hitch, 1974; Engle, 2002). The present thesis aims to investigate the role of working memory in achievement goal pursuit. This holds much value in progressing motivational theory by offering some explanatory grounds for why these goals differentially relate to cognitive performance. This opening thesis chapter will evaluate the plausibility of such a relationship between achievement goals and working memory. Firstly, providing much encouragement for how differential engagement of working memory resources by achievement goals might influence learning and performance, this chapter will review the literature which illustrates the important role of working memory in shaping learning and performance (*Working Memory*). It will then address research which has broadly examined the relations between working memory and various affective and motivational states, providing insight into the potential of achievement goals to influence working memory (*Working Memory and Psychological States*). Following that, the present chapter will consider findings which direct broad attention to the relationship of the achievement goal approach with cognition (*Achievement Goals and Cognition*). Key limitations and areas of neglect within the literature fuelling the current thesis aims will then be highlighted and implications for the research to be presented in the current thesis will be outlined (*Methodological Concerns and Research Objectives*). Finally, core objectives in attending to the primary research aim will be presented via a succinct overview of the intended research studies in forthcoming chapters (*Research Program*).

Working Memory

Working memory is crucially involved in the performance of complex tasks. Researchers have been interested in the role that working memory plays in skill execution (Engle, 2002), and in the impact of negative or highly pressurised environments on various task strategies and performance outcomes (Ashcraft & Kirk, 2001; Schmader & Johns, 2003). These areas of research have taught us much about learning and performance, but too often have these research areas operated in isolation. Specifically, the literature tells us much about the construction of working memory and how it relates to superior cognitive functioning, but less in known about the role of working memory in environmental manipulations that shape the strategies that individuals engage in during skill execution (Schunn & Reder, 2001). Moreover, even less research has addressed how strategic differences here might vary as a function of cognitive load (Miyake & Shah, 1999). As Baddeley (2007) stresses, "*the development of cognitive psychology as an information-processing discipline has been hugely productive... If we are to continue to advance, it is clearly important to go beyond cognition and try to understand not only how behaviour is controlled, but why."* [p. 348].

Working memory is argued to play a critical role in goal-directed behaviour (Miller & Cohen, 2001). The Multicomponent Working Memory model (Baddeley & Hitch, 1974) is undoubtedly a significant chapter in the history of cognitive psychology. Stemming from a series of memory systems attempting to account for the flow of information through a simple unitary short-term store, from the environment and then to a more long- term store, (e.g., Atkinson & Shiffrin, 1968; Shallice & Warrington, 1970), the study of working memory was initiated from the acknowledgement that such interface between sensory attention and memory involved much more than just simple short-term storage. Rather, working memory was proposed to be involved more heavily in attentional control, supported by consistent findings that little to no accuracy decrements on various verbal reasoning and comprehension tasks result under the influence of a concurrent memory task (e.g., reciting digits) (Baddeley, 1986; Hitch & Baddeley, 1976), suggesting a much more active system at play than that of just simple storage of information. Thus, a multimodal working memory system which accounted for the active maintenance and manipulation of information in immediate memory was proposed. Since the introduction of this functional system almost 40 years ago, a thriving and thorough working memory literature has evolved and continues to do so.

Although the research presented in the current thesis adopts a broad, non-component specific, processing perspective on working memory, it is important to outline the fractionation of the model. Specifically, Baddeley and Hitch (1974) proposed a three component working memory model compromising of the *central executive*, a limited capacity controller, and two sub-systems including the *phonological loop*, involved with verbal and acoustic information, and the *visuospatial sketchpad*, concerned with visual and spatial information. Both sub-systems were assumed to comprise a storage and rehearsal like mechanism which were both, but differentially, limited in capacity. This model was later expanded to include a fourth component, the *episodic buffer* (Baddeley, 2000), proposed to form an interface between the other three components and long-term memory, a ‘workspace’ for the other components.

Much working memory research has been concerned with developing detailed accounts of the model, gaining a deeper understanding of the role and relevance of each of the four components through the use of carefully designed experiments (for a review see Baddeley, 2010). Such research has enabled firm conclusions regarding the importance of working memory for performance of complex tasks, language comprehension, general intelligence, retrieval of information and frontal lobe functioning, for example (Baddeley, 1996; Daneman & Carpenter, 1980; Kronenberger, Pisoni, Colson & Henning, 2010; Moscovitch, 1992; Shallice & Burgess, 1993). For example, the phonological loop has been argued to support the acquisition of a native language in children and in adult second-language learning by maintaining the representation of new words (Baddeley, Gathercole, & Papagno, 1998). Conversely, the visuospatial sketchpad has been implicated in sentence processing (Phillips, Jarrold, Baddeley, Grant, & Karmiloff-Smith, 2001). The limited capacity central executive is considered the most important component of the multimodal model due to its role in attentional control (Baddeley & Logie, 1999). Based upon considerable evidence involving patients with frontal lobe damage (executive processes critically depend upon frontal lobe functioning; Kane & Engle, 2002; Stuss & Knight, 2002), the central executive is proposed to involve four important processes; the capacity to focus attention, to divide attention, to switch attention and to provide a link between working memory and long-term memory (Baddeley, 1996). This episodic buffer is suggested to combine information from the loop, sketchpad and long-term memory into a coherent episode, but is limited in the number of chunks that can be maintained, and dependent upon the capacity with which the central executive can operate (Baddeley, 2000; Cowan, 2005). What research undeniably confirms here is the limited capacity nature of all these components.

The term *Working Memory Span* was introduced from the development of tasks which required the simultaneous storage and manipulation of information in immediate memory, consistent with the multicomponent working memory model (Daneman & Carpenter, 1983; Daneman & Tardif, 1987). Span, a useful measure of individual differences in the capacity of working memory, captures the limited capacity nature of the working memory system. That is, working memory span (capacity) represents the limit of information that can be maintained and manipulated in working memory, which constrains cognitive performance. Span tasks require participants to, for example, read a series of sentences out loud and then recall the last word of each, with number of words recalled determining span (Daneman & Carpenter, 1980). Researchers employing such tasks have found working memory span to predict language comprehension (Daneman & Merikle, 1996; King & Just,

1991) complex task performance (Kyllonen & Stephens, 1990), reasoning ability (Kyllonen & Christal, 1990) and fluid intelligence (Engle, Kane & Tuholski, 1999a), to give some examples.

Researchers vary somewhat in conceptualising the limited capacity of working memory, and indeed the source of such limitations. Some attribute this limit to attentional inhibition (Hasher, Zacks & May, 1999), or executive attention limitations rooted in goal maintenance and conflict resolution processes (Kane, 2002), others implicate mental speed or suggest that capacity represents a limited pool of resources for short-term storage and processing of information (Fry & Hale, 1996). However, there is consensus that the 'availability' of working memory can be manipulated. For example, LaPoint and Engle (1990) have shown that spans are, on average, smaller when the words to be remembered are longer. Lobley, Baddeley and Gathercole (2005) observed that acoustic similarity among words to be remembered also reduces span, although this depended on the particular response process raising the potentially important issue of strategy. Tehan, Hendry and Kocinski (2001) obtained effects of both word length and phonological similarity on complex span tasks.

Individual differences in working memory span have been found to predict a variety of processes and outcomes. It is typically proposed that one is more likely to perform well on various cognitive tasks when there is more available capacity (Colflesh & Conway, 2007). Superior capacity is associated with greater resistance to distraction, higher general intelligence and better academic achievement (Barrett, Tugade, & Engle, 2004). Studies have also shown that higher capacity predicts superior strategy use when encoding information (Cokely, Kelley, & Gilchrist, 2006; McNamara & Scott, 2001), and predicts hypothesis generation when making probability judgements (Dougherty & Hunter, 2003). Individuals with higher capacity have been found to employ more elaborative encoding techniques, whereas those with low capacity tend to rely on more rote-rehearsal approaches (Bailey, Dunlosky, & Kane, 2008; Turley-Ames & Whitfield, 2003). Interestingly, training of adaptive task strategies has been found to substantially increase reading span scores, illustrating the impact of strategies on measures of working memory capacity (McNamara & Scott, 2001). Dunlosky and Kane (2007) found that the proportion of task sets on a span task in which a participant reported using a deeper encoding strategy was positively correlated with working memory capacity. Others have also consistently shown that explicit strategy training on span tasks only seems to benefit low capacity individuals, suggesting that high capacity individuals, before training, were already using an effective strategy (Cokely, Kelley, & Gilchrist, 2006; Dunlosky & Kane, 2007). Importantly, although there appears to be no singular basis for working memory variation, such variation seems to determine how effectively individuals learn and use demanding task strategies, and may play some role in strategy choice.

Another approach to investigating working memory that further illustrates how variability in working memory can influence strategies and performance involves forming two groups of extreme low and high span individuals to be compared on another task of interest. A particularly influential study by Rosen and Engle (1994) got participants to generate items from semantic categories (e.g., to produce as many animals as possible within a specific time period), which is known to be reliant on executive capacity (Vallar & Baddeley, 1984b). High span individuals generated more category members relative to low span individuals, however, when this task was performed alongside a demanding secondary task, only the high span individuals suffered a performance impairment. Findings were interpreted as reflecting the reliance by high span individuals upon attention-demanding strategies, which are abandoned in the presence of a demanding secondary task, resulting in fewer category items being produced. Intriguingly, low span individuals showed no concurrent task effect, which, in line with the above interpretation, was suggested to reflect a lack of capacity to develop and utilise complex strategies, and thus the secondary task aimed at disrupting such strategies had little effect (Rosen & Engle, 1994). In fact, neuroimaging studies have found reduced activation in frontal brain regions when performing concurrent tasks, particularly when the primary task involves executive processing (Fletcher, Happe, Frith, Baker, Dolan, Frackowiak & Frith, 1995; Goldberg, Berman, Fleming, Ostrem, Van Horn, Esposito, Mattay, Gold, & Weinberger, 1998). This could be argued to reflect the abandonment of an attentionally demanding strategy used in single task conditions as just outlined for high-span individuals (Rosen & Engle, 1994).

The use of extreme span groups has been employed across a range of different tasks exploring secondary task decrements in high span individuals (Engle, Tuholski, Laughlin, & Conway, 1999; Miyake, Friedman, Rettinger, Shah, & Hegarty, 2001) providing robust support for the effect described. Arguably, this methodological approach maximises the likelihood of detecting strategic differences, but as Baddeley (2007) argues, even studies which use entire sample ranges, rather than extreme groups, still encounter a possible confound of different span performance levels actually reflecting differences in strategy use. In line with Baddeley's call for reintroducing motivation to cognitive psychology, in his 2007 review he suggests other, motivation based, interpretations of Rosen and Engle's (1994) findings just outlined. Firstly, it is suggested that a lack of motivation may have led low span individuals to put less effort into the span task and hence not bother to develop performance strategies even though they may have been perfectly capable of doing so.

Secondly, given that the low span subjects were capable of performing both the category generation task and the secondary task with little decrement in comparison to the generation task alone, it would seem that they were under-using available attentional resources. Baddeley's (2007) account here highlights possible, motivation fuelled, strategic allocation of attentional resources holding great relevance to the current thesis aim.

Another area of research which offers further insight into the role of working memory in shaping possible task approaches is the investigation of interference effects. For instance, Cantor and Engle (1993) presented a series of invented facts to participants such as *the priest is sleeping* and *the mayor is on the boat*, and then in another condition, called the fan effect, presented facts attached to the same person, e.g., *the solider is sleeping* and *the solider is on the boat*. Participants are then presented with sentences and required to verify whether or not it is true. It is suggested that verification response times are much slower when facts presented are for the same person (i.e., the solider) because of interference during retrieval amongst the competing associations for that person concept (Anderson & Reder, 1999). Cantor and Engle (1993) specifically found that the fan effect condition resulted in slower verification times for low span relative to high span individuals, suggesting that low span individuals suffer more from interference from competing associations. Kane and Engle (2000) also presented participants with three different lists of ten words from different semantic categories, to be recalled, finding that low span individuals experienced greater decline across successive lists than high span individuals. Such findings are argued not only to reflect low span individual’s more limited executive capacity, but more specifically their heightened susceptibility to interference. Interestingly, it has also been found that when participants are required to shadow a continuous spoken message in one ear and ignore messages read in another ear which included embedded references to the participants name, high span individuals are less likely to report hearing their name demonstrating superior inhibition of unwanted information (Conway, Cowan, & Bunting, 2001). Such inhibition is assumed to be attentionally demanding (Engle, 1996), suggesting that the greater available capacity of high span individuals is what gives them the advantage of reducing interference from competing or unwanted information. Other researchers have found similar effects by showing that increases in working memory load result in greater interference on a primary task, illustrating that working memory facilitates goal-directed control by limiting the interference of goal-irrelevant information (De Fockert, Rees, Frith & Lavie, 2001; Lavie & De Fockert, 2005; Lavie, Hirst, De Fockert & Viding, 2004). Ultimately, the discussed research suggests that when there are fewer working memory resources available, one is less likely to keep attention focused on selective task properties, in other words, that less resources possibly means an individual is more susceptible to alternative possibilities.

Working Memory and Psychological States

Investigation of working memory is proving more and more useful in many areas of application, such as in antisocial behaviour (Moffitt, 1993), dysregulated behavioural disorders (Barkley, 1997; Dovis, Van der Oord, Wiers, & Prins, 2010), and alcoholism (Ambrose, Bowden, & Whelan, 2001). To illustrate the value of such integration, the collaboration of ideas from cognitive psychology with those from social and motivational areas has led to research findings which show implicit influences on executive control (Bargh & Ferguson, 2000), and that regulation of emotion-based goals requires cognitive resources (Baumeister & Heatherton, 1996).

To provide a more detailed illustration, Schmeichel, Vohs and Baumeister, (2003) suggest that ego depletion, the fatiguing of the processes underlying self-control, affects performance only on cognitive tasks that make reasonably heavy executive demands. For example, participants who are shown an emotional film and required to suppress any emotion perform worse on cognitive tasks which demand executive processing compared with tasks assumed to be less cognitively demanding (Schmeichel et al., 2003). Such findings suggest that ego depletion reduces the capacity or willingness of the subject to engage in active cognitive processing, which has little effect on performance for tasks that involve more automatic processing. As the authors infer, "*when the self is depleted by previous regulatory exertions, one set of mental processes is impaired, but another set is unaffected*" (Schmeichel et al., 2003). Thus as noted earlier, such research illustrates that regulation of emotion-based goals seems to require cognitive resources. Considering this in terms of the multimodal working memory model, ego depletion likely hinders the control functioning of the central executive. This is highly interesting in relation to the aims of the current thesis. If states such as ego depletion - when there is pressure on the processes involved in self-control - result in a reduction of the will with which one can engage the central executive there are clear implications for the current thesis research. Firstly, this suggests that emotional/motivational states can influence working memory, but also that it seems specifically states in which one might be more concerned with effort to suppress ones thoughts about the 'self' have a direct relationship with reduction in capacity.

Various other areas of research demonstrate a relationship between affective experiences and how well individuals perform cognitively, offering encouragement for a potential role of working memory in achievement motivation. For instance, depression and extreme positive emotions have been found to severely disrupt switching attention, memory and planning (Murphy, Sahakian, Rubinsztein, Michale, Rogers, Robbins, & Paykel, 1999). Depression in particular has been linked to deficits on tasks which require effortful processing such as executive functioning (Joormann, 2008). Unpleasant emotional states are generally found to reduce the availability of working memory (Gray, 2001; Gray, Braver, & Raichle, 2002). Experimental work inducing moods has also shown that poorer memory performance is associated with the experience of negative emotions (Seibert & Ellis, 1991). Furthermore, patients with emotional disorders have been found to suffer from poor memory performance, suggested to be a result of high state arousal narrowing attention. Thus, if the state of arousal demands a reasonable amount of one's limited attentional capacity then little capacity remains for other tasks (Dalgleish & Cox, 2002). Research here appears in line with the Resource Allocation Theory (Ellis & Ashbrook, 1988), suggesting that either the experience of negative emotions may capture attention, or attempts to regulate these emotions may place high demand on resources. From this one can conclude that any task that demands attentional capacity is likely to exacerbate effects of emotion. For instance, participants high in trait anxiety perform more poorly on primary reasoning tasks under a demanding secondary verbal task, relative to those low in trait anxiety. This is assumed to reflect the influence of increased anxiety induced by the introduction of a secondary task, which consumes available attentional capacity (MacLeod & Donnellan, 1993). Others have also implicated motivation in explaining relations between affect and cognition, in that poor motivation when in a negative state (rather than negative emotion per se) might be responsible for poor executive performance. Researchers have found that a lack of initiative to allocate resources to a task was better able to account for performance on a learning task relative to the actual availability of resources (Hertel, 2000; Hertel & Rude, 1991). Thus, negative or disrupted mood may result in poor motivation to engage resources to the task, and rather direct resources to regulating or repairing mood.

Given the findings relating to negative emotions, positive affect therefore is assumed to result in more superior working memory performance. Although some findings support this notion (e.g., approach-motivated positive states predict superior cognitive performance; Gable & Harmon-Jones, 2010a), other research seems to suggest that positive mood can impair executive functioning due to increased distractibility (Phillips, Bull, Adams, & Fraser, 2002). It is perhaps therefore not correct to always assume distinct effects of extreme psychological states as there may be exceptions. One might ask under what conditions might we reduce the influence that high arousal has on cognitions. Lavie (1995; 2000) has shown that the potential of irrelevant stimuli to disrupt processing may decrease as the central task becomes more challenging because attention becomes more focused on the relevant stimuli. This suggests that effects of high emotional arousal may be reduced when a primary task increases in difficulty by reducing the likelihood of intruding irrelevant thoughts. Indeed, empirical support for this notion is strong, with studies showing that irrelevant thoughts can be reduced when individuals are required to keep the central executive engaged on another task, such as uttering single random words at random points in time, and ensuring that performance on a primary task does not become automatic (Teasdale, Segal, & Williams, 1995). Given that a sustained focus on cognitive tasks is related to continued availability of the central executive (Teasdale et al., 1995), it seems plausible to suggest in line with current thesis aims that states which facilitate a broader scope of attention are more likely to maintain a task focus.

Another area of research which has taught us much about the connectivity between psychological states and cognition concerns the *worry hypothesis.* That is, under conditions of threat, one becomes preoccupied with thoughts of what might go wrong leaving less capacity for the task at hand. Researchers have found using recall tasks that under such conditions performance can be maintained only if more effort is invested (Calvo, Eysenck, Ramos, & Jimenez, 1994). When more effort is not sufficient, then it is common for one to adopt different strategies to maintain performance, i.e., to develop coping strategies to compensate (Eysenck & Calvo, 1992). This idea of maintaining performance via the adoption of different task strategies offers some relevance to differentiating the connectivity between achievement goals and cognition within the current thesis. Findings discussed so far in this chapter subsection provide good indication that affective thoughts do occupy working memory capacity. It seems that certain psychological states lead to thought patterns which reduce the processing capacity of working memory available for a task at hand. Overall, the clear evidence that emotional states influence performance via attention resources provides much encouragement for the current thesis aim.

Such encouragement is further fuelled by research which has specifically considered the impact that motivational states have on working memory processes. Links between motivation theories and broad 'memory' performance is clearly evident in the literature. Such performance is influenced by rewards and reward competition (Nilsson, 1987; Weiner, 1966), goal-setting (West, Thorn, & Bagwell, 2003), self-determination (Deci & Ryan, 1985; Ryan & Deci, 2000) and self-worth (Covington, 1984). Distinct relations to cognitive performance and processes have been found for broad motivational states of approach (positive stimuli focus) and avoidance (negative stimuli focus) (e.g., Gasper, 2004; Gray, 2001; Isen, Niedenthal, & Cantor, 1992), and for various goal pursuit states (e.g., Ferguson & Bargh, 2004; Hamilton, Katz, & Leirer, 1980b; Kanfer & Akerman, 1989; Winters & Latham, 1996) for example. Even stable trait variables such as impulsivity demonstrate clear motivational effects on cognition (Pickering, 2004). One particular motivation theory that has been linked to distinct patterns of cognitive processes is Regulatory Focus (Higgins, 1997; 1998), a theory which proposes that there are two separable approaches to goal fulfilment. The first of which is a 'promotion focus', which emphasises the presence or absence of positive outcomes, and secondly a 'prevention focus', which emphasises the presence or absence of negative outcomes (Higgins, 1997). These approaches are characterised by some authors in the motivation literature as synonymous with approach and avoidance respectively (Carver & Scheier, 1990; 1998).

Research indicates that a promotion focus is related to more flexible and exploratory cognitive processing, whereas a prevention focus in related to more rigid and vigilant cognitive processing (Higgins, Roney, Crowe, & Hymes, 1994: Maddox, Baldwin, & Markman, 2006). As will be elaborated in chapter 6, further research suggests that when the regulatory focus (promotion or prevention) matches the reward structure of a task (regulatory fit), there is likely to be an increase in executive working-memory resources. Conversely, a mismatch or lack of regulatory fit (i.e., when the focus and reward structure don't align; e.g., having a prevention focus on a task which rewards gains, or, having a promotion focus on a task which punishes losses) causes decrements in available executive resources (Grimm, Markman, Maddox, & Baldwin, 2008; Worthy, Markman, & Maddox, 2009). Consistent with the limited resources model of executive attention (Muraven & Baumeister, 2000), it is proposed that, because of its association with more flexible cognitive processing, a promotion (approach) focus should be less likely to deplete executive attentional capacity, but rather remediate performance when in a situation which demands executive capacity (Trawalter & Richeson, 2006).

Working memory is suggested to also be associated with a related motivation theory, that of Action-State Orientation (Kuhl, 1984, 1994, 2000; Kuhl & Beckmann, 1994). An action orientation is conceived as a regulatory mode involving decisiveness and initiative, whereas, a state orientation is conceived as a regulatory mode involving indecisiveness and hesitation. These orientations refer to the efficiency by which individuals instigate changes necessary to enact a particular motivational tendency (Jostmann & Koole, 2006). Research has illustrated that these orientations (often primed or induced by demanding or accepting schemas to promote a host of goal foci; Koole & Jostmann, 2004) moderate the impact of demands on working memory capacity. Research has shown that a state orientation results in less efficient use of working memory capacity under increasing demands, whereas, an action orientation results in the better use of capacity with increasing demands (Jostmann & Koole, 2006). A state orientation is found to 'hold on to' information in working memory even when it is irrelevant, i.e., when less information is actually more desirable for decision making, demonstrating an overall tendency to over engage working memory resources (Goschke & Kuhl, 1993). An action orientation on the other hand, exaggerates the tendency to update working memory more, resulting in better utilisation of capacity under high demands, while under low demand conditions these effects diminish due to less strain on working memory (Jostmann & Koole, 2006). It seems that high demands may lead some to more strongly/efficiently engage resources than others (Botvinick, Braver, Barch, Carter, & Cohen, 2001), depending upon ones psychological or behavioural state.

Research more broadly suggests that high levels of motivation result in stronger persistence on cognitive tasks (Ryan & Deci, 2000) and better interference control (Kuhl, 1987). Brose, Schmiedek, Lövdén, Molenaar and Lindenberger (2010) found that higher reports of increased task effort and enjoyment (defined as motivation by authors) predicted better working memory performance accuracy. More specific research examining the role of working memory in goal-setting tasks has shown that the pursuit of specific and difficult performance goals (e.g., "recall at least 18 out of 24 words"), versus "do your best" goals or no goal assigned, enhances the speed of scanning information in working memory and facilitates working memory capacity. This is particularly the case in high load sets or conditions, even when persistence, ability and speed-accuracy trade-off is controlled for (Sternberg, 1975; Treisman & Doctor, 1987; Wegge, 2001; Wegge Kleinbeck, & Schmidt, 2001), suggesting that motivational effects are more likely to emerge under more demanding conditions. These goal setting effects have also been found to maintain when working memory is positioned as a secondary task paired with a simple primary task (DeShon, Brown, & Greenis, 1996). Self-reports of task motivation 'to perform well' is also found to correlate with working memory capacity (r = .31) (Medeiros-Ward, Seegmiller, Watson & Strater, 2011).

Incentives have too been found to have strong effects on attention with research illustrating that rewards can change participants attention during encoding or rehearsal for reward-associated information (Loftus, 1972). Specifically, participants in higher monetary reward conditions perform significantly better on working memory span tasks than participants in no incentive conditions, and the extent of this performance increment is statistically identical for high and low span subjects (Heitz, Schrock, Payne, & Engle, 2008). Krawczyk and D'Esposito (2011) investigated the influence of motivation in terms of monetary punishment on a working memory task, and found that performance was faster and more accurate under conditions of loss-threatening incentives. Neuroimaging studies also provided evidence for the integration of motivation and executive processes via correlated activity between the orbitofrontal cortex (OFC; associated with emotion and motivation) and dorsolateral prefrontal cortex (DLPFC; associated with executive processes responsible for working memory). When a working memory task is performed, the DLPFC together with OFC areas, show reward-dependent (high vs. no monetary reward) changes in strength of activity (Pochon, Levy, Fossati, Lehericy, Poline, Pillon, Le Bihan, & Dubois, 2002; Szatkowska, Bogorodzki, Wolak, Marchewka, & Szeszkowski, 2008), with further differences in activity observed across encoding, maintenance and retrieval stages (Taylor, Welsh, Wager, Phan, Fitzgerald, & Gehring, 2004). As Taylor et al. (2004) assert, "*Working memory must interact with functions that determine value for the organism*", and indeed, the discussed research demonstrates clear connectivity between motivation and working memory.

Bengtsson, Hakwan and Passingham (2009) found that motivational manipulations of ‘to do well as your ability is being assessed’ (considered high motivation group), versus ‘this is a pilot task to optimise parameters’ (considered low motivation group), resulted in enhanced neural responses to errors on the N-Back working memory task (requires participants to monitor a stream of stimuli and decide for each whether it was presented a given number of positions back in the sequence stream). Interestingly, activity differences between these just described motivational groups were found in the anterior paracingulate cortex which has been found to be activated when participants self reflect (Kelley, Macrae, Wyland, Caglar, Inati, & Heatherton, 2002; Ochsner, Beer, Robertson, Cooper, Gabrieli, Kihsltrom, &

D'Esposito, 2005) suggesting that when motivated individuals expect their abilities to be evaluated they treat errors as being in conflict with their wish to do well. Slower reaction times in the higher load conditions of a working memory task (N-Back) were also found for the ability motivated group in comparison to the low motivation group. Such research illustrates some understanding of how motivation and working memory are integrated in terms of neural processes.

The extent to which achievement-based motives actually exert an effect on cognitive processing has also been addressed. Researchers have shown that participants primed with achievement motive words (e.g., master, compete, achieve) prior to performing tasks considered to demand executive processing, scored more highly than those primed with neutral words (e.g., carpet, window, hat) (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Hassin, Bargh, & Zimerman, 2009). Achievement based primes have also been found to reduce Stroop interference (Kazen & Kuhl, 2005). Still another area of work that provides promising insight into the potential role of working memory in achievement motivation concerns emotional modulation of cognitive control. For instance, Gray (2001) found that spatial working memory performance was enhanced by avoidance states but impaired by approach states (both induced through the use of video clips), and that the exact opposite pattern held for verbal performance.

Research findings have also shown that poorer spatial working memory performance (N-Back) is evident when reports of reduced task-related motivation are higher (i.e., self-reported lack of motivation to work on a task) (Brose, Schmiedek, Lovden, & Lindenberger, 2011). Fascinatingly, when both working memory performance and task-related motivation were measured across time, these authors found that fluctuations in reported motivation were related to variations in working memory performance (when reported on task motivation was high, memory performance was stronger) (Brose et al., 2011). As previously noted in this chapter, being in a motivational state in which the self has less resources than normal (i.e., ego depletion) results in diminished ability to function optimally due to less efficient use of working memory capacity (Schmeichel, Vohs, & Baumeister, 2003), competition anxiety and disruption of the central executive (Eysenck, 1985; Tobias, 1985; Wine, 1971). In addition such states are linked with task-irrelevant and intrusive thoughts known to hinder working memory processing (Lavie, 1995; 2000; Linnenbrink, Ryan & Pintrich, 1999).

It is necessary to outline that some researchers have found that motivational effects on memory performance (general immediate recall) disappear when strategies underlining superior performance are removed (Nilsson, 1987). Ngaosuvan and Mantyla (2005) manipulated extrinsic motivation through competition instructions on a task in which possible strategic differences contributing to item-specific biases during encoding or retrieval were removed. These researchers found no effect of motivation (relative to those receiving no motivational manipulation) on recall in such task conditions. This clearly outlines the critical role that task strategies might play in understanding the interplay between motivation and cognition. Obviously motivation is important for cognitive control (Engle, 2002), but findings discussed specifically illustrate that a more in-depth motivation-cognition relationship exists; that various motivational states, broadly construed, impact upon working memory. Clearly this research provides much encouragement for the view that motivational states may partly account for *why*, in terms of different motivation states, working memory processing differences might occur across different situations.

Achievement Goals and Cognition

The achievement motivation literature has flourished via a number of approaches over the past 70 years, stemming most predominately from the work of Kurt Lewin and colleagues with their level of aspiration approach (Hoppe, 1930; Lewin, Dembo, Festinger, & Sears, 1944). From this, various conceptualisations of achievement motivation emerged including the theoretical focus on achievement motives (McClelland, Atkinson, Clark & Lowell, 1953; McClelland, Clark, Roby, & Atkinson, 1949), attribution theory (Weiner & Kukla, 1970) and of present interest, the achievement goal approach (Elliot, 1999). Particular motivational foci of interest have included for example, being driven by implicit or explicit needs (McClelland, Koestner, & Weinberger, 1989), being intrinsically or extrinsically orientated (Deci, Koestner, & Ryan, 1999), being driven by gains or losses (Freund & Ebner, 2005), and being either outcome or process focused (Sansone & Thoman, 2005).

The achievement goal approach is a social-cognitive account of achievement motivation, and has arguably received the most attention in studies concerning human motivation (Dweck 1986; Elliot, 1999; Nicholls, 1984). As noted at the start of this chapter, two distinct forms of achievement goals have dominated the literature, that of a *mastery* and that of a *performance* type of competence specific goal focus. A mastery focus is concerned with the development of self-referential competence, through task mastery, whereas a performance focus is concerned with the demonstration of competence relative to others (Elliot, 2005). That is, at least in their *approach* forms, both of these goals are concerned with achieving competence, but a mastery focus is concerned more with doing better than one has previously done or achieving a personal best (developing competence), and a performance focus is concerned with doing better than others have or might perform (demonstrating competence). These achievement goals thus differ in the extent to which successful goal pursuit is defined. For mastery goals, successful pursuit is about meeting a self-referential standard, i.e., you have succeed when you have developed a skill/mastered a task, whereas for performance goals successful pursuit is about meeting a normative standard, i.e., you have succeed when you have surpassed most others.

It was the work of Elliot (1994) which led to the approach-avoidance distinction specifically within the achievement goal domain. Elliot recognised that performance goals had both positive (e.g., academic achievement, high levels of effort, persistence, intrinsic motivation) and negative (e.g., surface processing and learning, low persistence following failure, withdrawal) (Dweck & Leggett, 1988; Elliot & Dweck, 1988; Elliot & Harackiewicz, 1996; Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997; Nolen, 1988) implications. This led to a series of reviews (Elliot, 1994; Rawsthorne & Elliot, 1999) which revealed that when a performance goal focused attention to more positive potentialities (i.e., an approach focus) more positive effects were observed, whereas when this focused attention to more negative potentialities (i.e., an avoidance focus) more negative effects were observed.

Elliot’s work resulted in the explicit breakdown of performance goals into an approach and avoidance dimension, creating a trichotomous framework of mastery, performance-approach and performance-avoid (Elliot, 1999; Elliot & Church, 1997; VandeWalle, 1997). Researchers proposed, with the support of empirical research (e.g., Elliot & Harackiewicz, 1996), that a performance goal focus includes motivation to either to demonstrate normative competence (performance-approach), or to avoid demonstration of normative incompetence (performance-avoid) (Elliot, 1999). Although a mastery goal had shown more of a consistent relationship with adaptive effects (e.g., persistence in the face of failure, deep processing of information, adaptive patterns of attribution, perceive difficult tasks as challenging, increased effort, academic performance) (Button, Mathieu & Zajac, 1996; Dweck, 1986; Fisher & Ford, 1998; Meece, Blumenfeld & Hoyle, 1988), Elliot argued that this was due to an entire focus on positive potentialities within experimental and field work and so it too received the approach-avoidance distinction to form a later, research supported, 2 x 2 achievement goal framework (Baranik, Barron & Finney, 2007; Elliot & McGregor, 2001). Thus, a mastery goal focus includes motivation to either focus on the development of self-referential competence (mastery-approach) or to avoid self-referential incompetence (mastery-avoid; avoiding deterioration of self-referential competence) (Baranik et al., 2007; Elliot & McGregor, 2001). Integration of the approach-avoidance dimensions therefore assisted in explaining the inconsistencies observed within the achievement goal literature and, most importantly, informed us how the defined focus to develop self or demonstrate normative competence is directed. The current thesis is concerned with the founding dichotomous achievement goal model; on the influence of mastery-approach and performance-approach on working memory.

As also briefly noted at the start of the chapter, researchers have conceptualised these goal foci as individual differences variables (VandeWalle, 1997; VandeWalle et al., 1999), but also as motivational states that are elicited by particular cues, settings or instructions (e.g., Chen et al., 2000). It is imperative to reiterate that the for the purpose of the current thesis aim, concern throughout the research studies to be presented in this thesis is only with the approach and state forms of mastery and performance goal foci. That is, investigation of the role of working memory specifically in state mastery-approach and state performance approach pursuit is of current interest.

These motivational foci (both measured and experimentally manipulated) have been found to share distinct patterns of association with achievement outcomes (as just indicated when describing research surrounding approach and avoidance distinctions), with mastery-approach often beneficially relating to more adaptive outcomes and performance-approach demonstrating a more mixed association with both adaptive and maladaptive achievement strivings and learning (Dweck & Leggett, 1988; Elliot & Dweck, 1988; Payne, Youngcourt, & Beaubuen, 2007; Rawsthorne & Elliot, 1999). There is some evidence that performance-approach is positively related to anxiety and negative affect in learning contexts (Chen et al., 2000; Linnenbrink et al., 1999). Consequently, researchers have suggested that when one is focused on demonstrating skill, it can come at the expense of developing appropriate strategies. However, other research has found no evidence that anxiety differs as a function of ones achievement goal (Pintrich & Garcia, 1991), but also that performance-approach is uncorrelated or weakly correlated with anxiety (Wolters, Yu & Pintrich, 1996; Middleton & Midgley, 1997; Skaalvik, 1997). Moreover, performance-approach has also been found to positively correlate with positive affect and metacognitive strategy use during a comprehension task, and to be unrelated to negative affect and task-irrelevant thoughts (Linnenbrink & Pintrich, 2002). Findings here are therefore mixed and arguably task-dependent.

As pointed out at the very start of this chapter, research which has typically focused on the relations of achievement goals (again, both measured and experimentally manipulated) to cognition has been heavily focused on questionnaire assessments of cognitive and metacognitive strategy use (e.g., Bell & Kozlowski, 2008; Elliot et al., 1999; Meece et al., 1988; Wolters, 2004). Before reviewing such research it is important to be clear that researchers have differentiated between two general information processing strategic approaches which can be adopted when learning new material; that of surface and deep processing (Marton, Hounsell, & Entwistle, 1984). Surface processing is an approach which involves focusing on facts by using simple cognitive strategies such as rehearsal, whereas, deep processing involves more focus on the meaning of material and use of more elaborative cognitive strategies such as summarising, paraphrasing and creating analogies. This distinction is parallel, for example, to rote and meaningful learning (Ausubel, 1963).

Studies have consistently shown that mastery-approach tends to positively predict the use of more complex and deeper strategies, with relations specifically to critical thinking, elaboration, monitoring, planning and integration of new information with prior knowledge (Anderman, Griesinger, & Westerfield, 1998; Anderman & Young, 1994; Elliot et al., 1999; Meece et al., 1988; Miller, Greene, Montalvo, Ravindran, & Nichols, 1996; Pintrich & Garcia, 1991; Pintrich & Schaureben, 1992). Mastery-approach has also been consistently linked to allocation of more task-related effort, such as trying out new strategies and exploring a task domain (Fisher & Ford, 1998). Thus a focus on developing self-referential skill tends to engage more effortful cognitive processes via strategies that demand a deeper understanding of material being presented. Importantly, mastery-approach is suggested to be negatively related to the use of suboptimal, ineffective or surface processing strategies (Kaplan & Midgley, 1997). That is, this motivational focus seems to encourage a reduction in the reliance upon less attentionally demanding approaches. Given that research has found a mastery-approach focus to increase development of more coherent knowledge structures and increased self-regulatory processes (Kozlowski & Bell, 2006; Stevens & Gist, 1997), it could be suggested that a focus on developing self-referential competence promotes superior investment of attention.

In contrast to the above, a performance-approach focus tends to predict engagement of more surface-level strategies, which involve rehearsal and rote memorisation techniques (Harackiewicz, Barron, & Elliot, 1998; Kaplan & Midgley, 1997). This motivational focus tends to divert some attention away from the task at hand through focusing on scoring well rather than on improvement (Ames, 1992; Fisher & Ford, 1998; Pintrich, 2000a) and thus tends to be less associated with deeper strategy reliance (Pintrich & Gracia, 1991). Elliot et al. (1999) found that a performance-approach focus positively predicted surface strategies but also effort and persistence, although other findings indicate that persistence is stronger and more evident for a mastery-approach focus (Wolters, 2004). Thus, performance-approach seems to elicit a focus more on 'learn just the essentials' in order to do well. Rehearsal strategies seem to be particularly related to this goal focus, which involves reciting items to be learned or saying words aloud as one reads assumed to help an individual attend to and select important information and keep information active in working memory. Focusing on demonstrating skill appears to involve less engagement of cognitive effort (Pintrich, 2000a).

Furthermore, findings have also shown that students reporting adoption of a performance-approach goal during classes reported greater use of effort-minimising strategies such as guessing at answers or skipping hard parts, whereas, those adopting a mastery-approach goal reported greater regulation of their attention and attempts to integrate information in order to solve problems (Meece et al., 1988). McGregor and Elliot (2002) found that mastery-approach is significantly related to deeper task absorption, (i.e., "while studying I get totally absorbed in what I'm doing"). Although there have been some exceptions to this pattern of results - in terms of performance-approach also being linked to effective cognitive strategies (Pintrich & Schurben

1992; Nolen, 1988; Wolters et al., 1996), and on occasions no relations being observed (Pintrich, 2000b) - the distinct patterns of relations between achievement goals and cognitive strategy use has led to the proposition that these motivational foci only play a role in fostering differential performance through links to the use of cognitive strategies (Pintrich, 2000b).

Mastery-approach goals have been found to specifically relate to more explorative learning techniques (Hulleman, Durik, Schweigert, & Harackiewicz, 2008) often requiring broad availability of attentional resources. Whereas, performance-approach goals are related more to aspirations to perform well and persistent task approaches to achieve such aims (Elliot, Shell, Henry, & Maier, 2005; McGregor & Elliot, 2002), meaning it likely that such normative goal pursuit fosters more strategic investment of attentional resources which arguably might not be so productive when actual performance necessitates broader availability of cognitive resources. Thus, it is not the case that one motivational focus promotes *more or less* reliance on cognitive strategies, but rather that each motivational focus engages *different* strategic approaches. In other words, these achievement motivation foci tend to use different cognitive strategies to control learning and performance. Curiously, some studies have shown that the employment of complex cognitive processes is most likely when a combined high mastery-approach and low performance (although mostly specifically pertaining to its avoidance form) goal is adopted (Meece & Holt, 1993; Pintrich & Garcia, 1991). Conversely, others have found that high mastery-approach paired with high performance-approach is mostly associated with efficient cognitive processes (Bouffard, Boisvert, Vezeau & Larouche, 1995).

Research that has moved beyond self-reported cognitive strategies shows that a mastery-approach focus is linked with superior maintenance of categorisation strategies in recall tasks (Escribe & Huet, 2005), increased likelihood of problem solving strategy transfer (Bereby-Meyer & Kaplan, 2005) and improved comprehension and synthesis of information (Gist & Stevens, 1998). Escribe and Huet (2005) taught participants to use a categorisation strategy in a recall task involving typical items, and then, in a subsequent transfer task performed under achievement goal inducement, asked participants to recall a typical or a typical list. It was found that regardless of the typicality of the items, a mastery-approach goal focus promoted maintenance of the categorisation strategy and of perception of its utility. Conversely, a performance-approach goal promoted maintenance of the taught strategy only on typical lists, whereas on the more demanding atypical lists they were more likely to divert away from the taught strategy. This clearly indicates that superior maintenance of a cognitive strategy is more evident for mastery-approach pursuit. Bereby-Meyer and Kaplan (2005) similarly taught a complex task strategy to participants on a problem-solving task, and got them to then complete a second, similar task to which the previously taught strategy could be applied. Pursuit of a mastery-approach goal predicted transfer of the taught complex strategy, whereas performance-approach pursuit was related to trial and error strategies during the second task. Perhaps due to the nature of a mastery-approach focus directing attention to increasing competence and mastering a task, it should be expected that employment of complex cognitive operations is highly likely.

When task conditions are less demanding, a performance-approach focus has resulted in superior cognitive performance to that of mastery-approach. For example, Steele-Johnson et al. (2000) found a performance-approach advantage, relative to mastery-approach, on a cognitive scheduling task but only during initial stages of skill acquisition (see also Yeo et al., 2008). Others have replicated this with superior cognitive performance demonstrated for a performance-approach, but only when task demands are low (Mangos & Steele-Johnson, 2001; Winters & Latham, 1996). It is not unreasonable to suggest that this effect is likely to be evident on parts of a task where simpler strategies might be advantageous initially. Mangos and Steele-Johnson (2001) suggest that this simply reflects the time-lag of mastery-approach effects, in that such goal pursuit will not have an influence of performance until more complex and effective strategies have been developed.

Although there exist clear relations between these achievement goals and cognitive strategies, such as the consistent relation of mastery-approach to more adaptive strategies, reviews reveal this motivational focus to be no more correlated, or even more weakly correlated, with achievement outcomes such as academic achievement, relative to a performance-approach focus (Harackiewicz, Barron, Pintrich, Elliot, & Thrash, 2002). Some have suggested that mastery-approach will relate to achievement only when this involves elaboration beyond available information (e.g., generating new ideas or going beyond direct instruction, Senko & Harackiewicz, 2005a). Ironically, it is exactly such curiosity that has been found to undermine achievement for mastery-approach, with some findings linking this focus to delving into material in great depth at the neglect of information that might actually be very important to task achievement. For example, Senko and Miles (2007b) found that students on an introductory psychology course who reported being higher in trait mastery-approach were more likely to engage in tangential studying (when attention is deliberately directed at more interesting and challenging material). These authors found that mastery-approach can result in unintentional sabotage of one's achievement by selectively focusing on interesting material, and that high trait mastery-approach students reporting a tendency to diverting straight to more interesting aspects of material to be learnt. Clearly it can be suggested from this that mastery-approach fosters deep engagement with material being presented, but ultimately this is not optimal in contexts or on tasks in which more superficial approaches are actually optimal.

One might be initially inclined to assume that a mastery-approach focus would facilitate high achievement due to a reliance upon deeper cognitive and learning strategies. However, it is possible that the most able students are more likely to be confident at adopting a goal to outperform others, which could explain these findings. Despite this, more field and experimental studies confirm that a mastery-approach focus does not necessarily result in better achievement than a performance-approach focus (Senko & Harackiewicz, 2005a; 2005b). In attempting to explain this, some have suggested that links between performance-approach and actual achievement must reflect achievement on a task which specifically assesses only surface learning, or in which surface learning can actually result in success (Midgley, Kaplan, & Middleton, 2001). It is suggested by Midgley et al. (2001) that if a task or exam more rigorously tested an individual's depth of understanding the link to achievement of a performance-approach focus would disappear. In line with this, others have found that correlations between performance-approach and actual achievement are particularly evident when examining multiple choice exam performance (Elliot & McGregor, 1999) or performance on introductory courses relative to senior-level courses (Barron & Harackiewicz, 2003), but less evident when the only way of performing a task is to engage more complex reasoning (Barron & Harackiewicz, 2001). Such research does indeed further encourage the view that performance-approach only enhances achievement in conditions of lower demand or at least when less attention demanding approaches can be adopted. Arguably, findings for performance-approach seem to suggest that this focus may prompt attention towards more key material to be learned, less likely to engage in more explorative learning, arguably quite strategic in their approach, or indeed invest strategic effort, in relying on surface strategies to meeting the essential demands and expectations of a task, rather than deeper learning. In fact, it has been found that competitive individuals who are apt to pursue performance-approach goals (Harackiewicz et al., 1997) tend to use a 'strategic approach' to studying characterised by heightened cue seeking and use of any learning strategy which produces the best grades (Entwistle, 1988). Unfortunately there has been little further empirical work addressing this. However, research seems to suggest overall that performance-approach typically fosters a lower-level construal which leads one to become highly attentive to expending only effort to meet specific demands. This is not to say that deeper strategies are not able to be engaged by this goal focus, but seem only to be engaged when absolutely necessary. Disappointingly, most of these propositions by researchers here are based on minimal empirical evidence.

Whether a mastery-approach or performance-approach focus is therefore more beneficial might arguably depend upon the attentional resource demands of a task, particularly the cognitive load of a task. Hofmann (1993) demonstrated that a performance-approach type focus cued individuals to devote limited attentional resources to thoughts unlikely to actually facilitate performance, thus this goal focus was more beneficial when attentional resource demands were low. Thus a mastery-approach focus might be more beneficial when cognitive load is at its highest, via strategies that are less disruptive to learning. As such, Steele-Johnson et al. (2000) speculate that, given that only a fixed (limited) amount of attentional resources are available, the achievement goal focus that cues an individual towards more automatic/routine processing is likely to be disruptive to performance, particularly when cognitive load is high. In that, if a particular achievement goal focus tends to engage in approaches which limit learning (e.g., performance-approach reliance upon surface strategies), then performance under high load will be limited. Importantly, the direction of this speculation is arguably dependent upon the nature of, and demands of, the task in question.

Theorising in relation to achievement goals and working memory specifically is also evident in the literature. For example, according to the Resource Allocation Theory (Kanfer & Ackerman, 1989) students who have a mastery-approach focus were assumed to have more of their working memory devoted to the task and task-related cognitions, which in turn would result in more effective cognition. On the other hand, students focused on performing well in order to please others may be using more of their working memory in thoughts about their performance and what others might think of them. Brophy (2005) in his review of the achievement goal literature suggests that when an individual’s motivation includes concerns about peer comparisons they are more likely to be distracted from an exclusive focus on learning because working memory resources are consumed by such comparisons. In other words, a performance-approach focus is thought to be cognitively distracting. However, it has also been proposed that students focused on mastering a task might be more willing to invest cognitively in a task, in contrast to those with a focus on obtaining a good grade in comparison to others who may be less willing to make such an investment in learning although this didn't necessarily come at a cost on actual ‘outcome’ achievement (Pintrich & Schrauben, 1992). Within such theorising it seems that there was some suggestion of ‘selective’ or ‘conscious effort investment’ based cognitive engagement, rather perhaps than specifically ‘disruption’ of engagement. Unfortunately, little early effort was directed at empirically addressing such claims.

The extent to which these associations might be explained by differences in allocation of attentional resources was proposed in the earlier work of Pintrich and colleagues (Pintrich & Garcia, 1991; Pintrich & Schrauben, 1992) in their multiple pathways to learning model. Pintrich and colleagues agreed, in line with the previously outlined pattern of associations between achievement goals and cognitive processes, that superficial versus deeper levels of cognitive engagement between mastery-approach and performance-approach, respectively, could help account for the differential relations to adaptive and maladaptive achievement outcomes.
However, Pintrich and colleagues were also interested in why such differences in cognitive engagement between these achievement foci prevailed. In a review of Pintrich's contributions, Harackiewicz and Linnenbrink (2005) note that "*a performance orientation might fill the limited capacity of working memory with thoughts about performance and ability which in turn may interfere with cognitive processing given the limited capacity of working memory, in contrast, a mastery orientation would focus the individual on the task at hand thus allowing for additional cognitive resources to engage in self-regulatory strategies such as planning and monitoring ones understanding"* (p.77). Pintrich (1999) argued that activation of prior knowledge when learning is common for those pursuing a mastery-approach goal, and that, activation of such knowledge could free up more capacity in working memory for superior strategies.

Empirical research broadly addressing these attention-based claims has been somewhat limited and presents mixed results. Graham and Golan (1991) got participants to encode or retrieve word lists at either shallow (rhyme based encoding) or deep (category based encoding) levels of processing under either an induced performance-approach goal, mastery-approach goal or no-goal control group (by providing introductory task aims prior to task engagement that focused attention on ability in comparison to others or mastery of the task respectively). It was found that pursuit of a performance-approach goal, relative to the other conditions, resulted in poorer immediate word recall at deep rather than shallow processing levels and specifically that this motivational-deficit was more pervasive at the recall rather than encoding stage. One possible explanation for these findings, as noted by Graham and Golan (1991) and supported by prior theoretical work (e.g., Humphreys & Revelle, 1984; Kanfer & Ackerman, 1989; Kanfer & Kanfer, 1991), is that pursuing a performance-approach goal interferes with working memory functioning, particularly central executive functioning, which is necessary to process information deeply. Thus, a motivated focus to demonstrate ones competence in comparison to others may well interfere with the cognitive resources needed for deeper levels of information processing. However a more self-referential goal focus (mastery-approach) in which more working memory resources are available based upon undivided attention to the task at hand results in superior recall performance. What these findings further suggest is that possible disruption under performance-approach pursuit may not be so much in placing information in memory but rather in utilising/acting upon such information.

In contrast with this, Barker, McInerney and Dowson (2002) used a similar manipulation method and found that participants experimentally induced into a performance-approach state performed better on a free and cued recall test than those induced into a mastery-approach state or those in a no-goal control group. Additionally, such differences consistent with Graham and Golan (1991) were particularly evident at deeper rather than shallow levels of processing. Barker et al. (2002) also found that for a mastery-approach state specifically, better recall was still present at deeper rather than shallow levels of processing. Importantly, neither Graham and Golan (1991) nor Barker et al. (2002) conducted manipulation checks on their state inducements. This means that the effectiveness of the manipulation methodology in these studies is unknown, and therefore the interpretation of differences between experimental groups is unclear.

In a more recent study, Murayama and Elliot (2011) suggest that because mastery-approach and performance-approach both represent appetitive investments in competence (Elliot, 1999), the ability of both to facilitate elaborative processing, just differentially, should be considered. These authors suggest, on the basis that mastery-approach goals are related to explorative learning (Hulleman et al., 2008), such goals should facilitate a broad scope of attention which will in turn facilitate consolidated associations in memory. On the other hand, given that performance-approach goals are linked to performance expectations and aspirations (McGregor & Elliot, 2002), this motivational focus is more likely to prompt narrower, instrumental, attention to essential/specific information to be remembered. With manipulation checks being supported, Murayama and Elliot (2011) found in a first experiment that there was no effect of induced achievement goal states overall in a recognition task, but when recognition was broken down into 'remember' (consciously recall) or 'know' (know it was there but don't consciously recall), goal differences emerged. Specifically, on immediate recall performance-approach pursuit related to superior 'remember' responses, whereas, mastery-approach pursuit related to superior 'know' responses. This pattern of effects was specifically found on an elaborative processing task (deep processing), but not on a more simple (shallow) processing task. In a second experiment these effects were confirmed in a deep-processing context, but mastery-approach pursuit was also found to foster superior 'remember' responses on a delayed recall condition. These results appear to confirm that mastery-approach pursuit promotes broad-based encoding (hence why this goal state related to better actual remembering on delayed recall but only 'knowing' on immediate recall). Conversely, performance-approach pursuit appeared to facilitate narrowly-focused encoding (hence why this goal state related to better actual remembering on immediate recall only). Murayama and Elliot (2011) conclude that mastery-approach pursuit leads to forming rich associations that are likely to consolidate over time, whereas, performance-approach pursuit leads to concentrated but narrow traces that help only in the short run.

In considering relations between achievement goals and working memory specifically, Huijun, Dejun, Hongli, and Peixia (2006) in a correlational investigation found that a trait form of mastery-approach shared no relation with working memory span (as measured by Reading Span; Dameman & Carpenter, 1980), but trait performance-approach was positively related to larger spans. Lower anxiety was found to be the mechanism by which trait performance-approach related positively to span. This provides encouragement that when negative affect is reduced or accounted for, performance-approach can share an adaptive relationship with attentional resources. However, Chen and Mathieu (2008) found a weak negative correlation between working memory capacity (as measured by a visual number span task; Ekstrom, French, Harman, & Dermen, 1976) and a trait measure of mastery-approach (r = -.17), and no correlation with trait performance-approach (r = .02). These authors also examined the unique and interactive effects of trait and state achievement goal orientations on a ‘money trail’ task know to demand working memory (Tomic, 1988). Performance trajectories during skill acquisition were examined on the task. Goal states were induced by framing the task with the purpose of “allowing them to improve their skill” (mastery-approach goal), or “to reveal how smart they are” (performance-approach goal). This goal frame manipulation was also paired up with a feedback frame in which participants were asked to either compare a current task block score to their previous block performance (mastery-approach) or to a specific normative performance score based on all students average score for a block during piloting (performance-approach). Findings revealed that neither trait or state achievement goals predicted performance trajectories. Although not reaching statistical significance, trait mastery-approach was found to positively correlate with improved performance on the working memory demanding task. Specifically, although performance on the first task block for such individuals was not that high, they did experience greater change between the first and final blocks on the working memory task. This arguably suggests that persistence of high cognitive effort for mastery-approach individuals becomes more beneficial to the task as the task itself becomes better learned. It can also be suggested therefore that such individuals perhaps have a tendency to engage more cognitive effort in order to do well.

More interestingly however when trait-state interactions were considered by Chen and Mathieu (2008), trait mastery-approach predicted task performance improvement more positively when coupled with a state performance-approach inducement, and similarly, an interaction between the state inducements of a mastery-approach goal frame coupled with normative feedback (performance-approach) also led to more positive performance trajectories. This suggests overall that a combination of both orientations can be complementary to improved performance on a task that demands available working memory capacity. This is fitting with the suggestions of other researches who have also found that a balance of achievement goals can be beneficial (Kozlowski & Bell, 2006; Meece & Holt, 1993; Pintrich & Garcia, 1991), again, holding clear implications for the current thesis as noted earlier. Disappointingly however, despite the fact that a measure of working memory capacity was taken by Chen and Mathieu (2008) it was not accounted for in these results, thus it is difficult to be sure what role individual differences in attentional capacity might have played in relation to these findings. Overall, these results are mixed and present a number of interpretative issues.

In other attempts to empirically address possible links between achievement goal states and working memory capacity, Linnenbrink et al. (1999) examined the relations of self-reported state mastery-approach and performance-approach with working memory following an unsuccessful attempt at experimentally inducing these states (through the provision of introductory task aim paragraphs). Linnenbrink et al. (1999) found a positive correlation between mastery-approach and working memory capacity scores (Reading Span, RSPAN; Daneman & Carpenter, 1980). It was also found that after controlling for negative affect, state performance-approach positively predicted capacity scores, consistent with the trait based findings of Huijun et al. (2006).

In a similar design using the same span task and a consistent state inducement method but with no manipulation checks applied, Parkes, Balliett and DiCintio (1998) found participants in a mastery-approach state group had higher working memory capacity scores than those in the performance-approach state and no-goal control group. It was also found that participants in the no-goal group made on average fewer working memory processing errors (sensibility judgements on sentences in the RSPAN) than those in the either of the other goal state groups (although performance-approach participants still made more processing errors than mastery-approach participants). After controlling for verbal ability, this difference was significant between the no-goal and performance-approach group. This suggests that when a more processing based working memory indicator is considered, a no-goal control group illustrates superior task performance to pursuit of either achievement goal state. This implies that representation of an achievement goal in itself might consume attentional resources which would otherwise be necessary for the processing, rather than just storage, of information in working memory. Others have confirmed that higher working memory capacity scores are particularly evident for state mastery-approach relative to state performance-approach and no-goal control conditions (DiCintio & Parkes, 1997). It has been mostly argued by these previous researchers that such findings indicate differential allocation of cognitive resources between achievement goal states, with performance-approach states directing attention to off-task cognitions (e.g., normative comparisons, anxious thoughts and concerns) that undermine effective use of cognitive resources, whereas, mastery-approach states direct more attention towards the task at hand (DiCintio & Parkes, 1997; Linnenbrink et al., 1999; Parkes et al., 1998).

Research discussed, despite findings being mixed, is clearly promising in terms of the possible, and potentially differential, role of working memory in the pursuit of state mastery-approach and performance-approach achievement goals. It is quite surprising given the central role of working memory in higher order cognitive processes, and the discussed links between achievement goals and cognitive strategies particularly under complex conditions, that the role of working memory in achievement goal pursuit has not been more thoroughly investigated to date. Interestingly, although the variability within this research area presents some interpretative issues, what can importantly be concluded is that goal effects between a mastery-approach and performance-approach focus, typically emerge under the more effortful cognitive conditions (Barker et al., 2002; Graham & Golan, 1991; Winters & Latham, 1996). This is perhaps because such effortful conditions allow for the full effect of the more superior, attention demanding, cognitive strategies employed by a mastery-approach goal focus as noted earlier (Bereby-Meyer & Kaplan, 2005; Escribe & Huet, 2005; Winters & Latham, 1996), to be exerted. This implies that examining achievement goal effects across load would be particularly advantageous, and that stronger motivational effects are likely to emerge when cognitive processing demands are at their highest.

Methodological Concerns and Research Objectives

A possible reason for the variability in findings relating to achievement goals and working memory is the methodological inconsistencies evident across studies. Although these will be more specifically addressed in chapter 2, it is necessary at this stage to illustrate such concerns. Many of the studies discussed that have examined effects of motivation states on working memory have problems relating to experimental and statistical control. For instance, the limited use of control groups and manipulation checks make it questionable as to whether comparison between experimental conditions or groups genuinely reflect the specific states of interest. Inconsistency in applying state manipulation checks amongst researchers not only results in different forms (experimentally manipulated versus self-reported) of state achievement goals being investigated, but unless motivational instructions are shown to be effective it is difficult to truly tell whether motivation impacts upon working memory. Failure to conduct manipulation checks means that it is possible that experimental manipulations were not effective.

This weakness also highlights some uncertainty on the extent to which variability in methods employed to elicit these states are actually influencing manipulation effectiveness. Manipulation methods to induce goal states across studies described have varied between a variety of methods (e.g., feedback frames and goal frames). As outlined, when manipulation checks are actually applied results seem to be mixed with some research inducements found to result in the desired effect (Chen & Mathieu, 2008; Murayama & Elliot, 2011), and others producing null results (Linnenbrink et al., 1999). To date, two meta-analyses have incorporated the investigation of induced achievement goals, one examining the differential relations between mastery and performance goals on performance outcomes (Utman, 1997) finding that mastery goals lead to better task performance, and the second, examining mastery and performance effects on intrinsic motivation (Rawsthrone & Elliot, 1999) finding that performance goal pursuit undermines such motivation. However, neither of these reviews thoroughly addresses the influence of different goal manipulation methods and the role of differing manipulation checks. Clearly, to competently progress in investigating the relationship between working memory and experimentally induced achievement goal states in the current thesis it seems imperative to, as a priority, review the issues surrounding the manipulation of achievement goal states.

A further limitation is that studies addressing the achievement goal-working memory relationship appear to be restricted entirely to set-based working memory span tasks which are more typically used within the literature as an individual differences measure (Conway, Kane, Bunting, Hambrick, Wilhelm, & Engle, 2005). Research has therefore been restricted to capacity indicators of working memory, highlighting a need for research to explore more continuous processing or complex working memory indicators in relation to achievement goal pursuit. Employing such a paradigm would actually allow for the control of pre-existing differences in working memory capacity, along with other relevant individual differences (e.g., cognitive ability). This leads to a further limitation, in that research described varies in controlling for related ability variables. The extent to which variation in cognitive performance for achievement goals goes beyond that of possible individual, and indeed group, differences in cognitive ability is not accounted for. Use of continuous working memory processing tasks within this research area will allow for working memory capacity measures and other relevant cognitive ability measures, to be more advantageously used as an individual difference indicator by controlling for any possible role such variables might play in observed achievement goal differences. The current thesis therefore aims to contribute to the understanding of the possible relations between achievement goal states and working memory whilst specifically attempting to overcome some of these methodological concerns.

There has been a clear outlining in the current chapter that motivation and cognition are related. However relatively little research (sufficiently small to be reviewed in its entirety within a subsection of this chapter) on the link between achievement goals and working memory is evident. It is presently argued that both the achievement goal and working memory literature would benefit from further attention to this link in terms of furthering understanding of the motivation-cognition interface. The present thesis therefore primarily aims to illustrate how considering the links between achievement goals and cognition can be fruitful. It is accepted that this is a somewhat bold step to take and that the research presented in this thesis will possibly only still scratch the surface of such a link. Yet, by doing so it is hoped that continued integrative research will be stimulated so that this very promising area of research doesn't get overlooked.

Critically, the present research thesis is not concerned with how being more or less motivated impacts upon cognition, rather, with how qualitatively distinct types of motivation impact upon cognition. As Pintrich and Schunk (1996) advance, motivation is "*the process by which goal-directed behaviour is instigated and sustained*". Motivation must play some role in controlling the allocation of attentional resources. Fundamentally therefore, it is proposed that qualitatively different motivational foci are the process by which cognition, specifically working memory resources, are either conciously or unconsciously allocated or engaged during the pursuit of achievement goals.

Thus in sum, the central hypothesis being investigated is that approach based achievement motivation states will influence working memory processing. That is, the role of working memory will vary in the pursuit of these two goal states. The limited research discussed and general ambiguity previously described, restricts the confidence with which specific directional predictions can be outlined at this premature stage within the thesis. However, given the discussed relations of mastery-approach to deeper and broader scopes of attention relative to performance-approach, it is expected that working memory may play a more important role in mastery-approach goal pursuit in comparison to performance-approach goal pursuit. A further key objective on the basis of such ambiguity is to extend understanding beyond the weak methodology previously discussed. That is, prior to specifically attending to these central hypotheses, meta-analytic investigation of state achievement goal methodology will be conducted in order to allow for more informed designs to be employed in the research studies of the current thesis. Finally, given the research illustrating not only that availability of attentional resources influences strategy use, but also that achievement goal states differentially rely upon cognitive strategies, progressive investigation beyond just gross measures of working memory performance is sought. That is, in order to reach better clarity on the achievement goal-working memory relationship, the current thesis sets out to also include examination of how possible differential relations between achievement goals and working memory might be reflected in task strategies.

Research Program

In attending to these objectives and hypotheses, the proposed research program is as follows:

Study 1 (Chapter 2): The experimental manipulation of achievement goals is common practice within the motivational literature, however the procedures surrounding such inducement are often inconsistent. Given that the present research thesis aims to employ manipulations of state achievement goals to investigate relations with working memory, a comprehensive quantitative review of the experimental literature in which state achievement goals are manipulated will be conducted. A groups contrast meta-analytic design is utilised in which standardised mean effect sizes (*d*) (Cohen, 1988) will be coded. Specifically, the effectiveness of different manipulation methodology on both manipulation check data and task performance data will be reviewed. The results of this review will then guide manipulation methodology employed throughout the current research thesis. It will be concluded that a multidimensional manipulation method involving the combination of an assigned task purpose with an associated goal frame is the most effective approach to inducing achievement goal states.

Study 2 (Chapter 3): On the basis of chapter 2 findings, a preliminary investigation of the relationship between achievement goals and working memory will be conducted. That is, the extent to which state achievement goals (adhering to the methodological results from chapter 2) influence working memory beyond weaknesses in previous research design will be investigated. On the basis that much of the discussed research in this opening chapter 1 has illustrated effects of motivation on cognition specifically under high cognitive load (or more complex conditions), a continuous working memory processing task (N-Back) in which load can be easily varied will be utilised. It will be concluded that achievement goals do influence working memory processing, specifically, that pursuit of a performance-approach goal limits processing under high executive load.

Study 3 (Chapter 4): In order to develop the insight from chapter 3 findings, dual-task methodology will be employed. The influence of a secondary working task varying in load, on a primary state achievement goal pursuit task will be investigated in establishing the extent to which state mastery-approach and state performance-approach goal pursuit, rely upon working memory resources. A primary word game task will be used, performed under low and high secondary load, which involves presentation of a letter matrix requiring participants to create words within time limits. It will be concluded given that mastery-approach pursuit results in a larger word game performance decrement from low to high load relative to performance-approach pursuit, that working memory plays a more vital role in state mastery-approach goal pursuit.

Study 4 (Chapter 5): In building upon the dual-task design of study 3 presented in chapter 4, study 4 will employ a primary goal pursuit task which varies in working memory intensity. This is on the basis that if secondary working memory load consumes capacity available for completing the primary goal task, then parts of the task which depend more heavily on working memory should suffer the most. This effect will be more evident for the goal state which prompts the heaviest reliance upon working memory. Self-reported strategy use is also measured in the current study in order to shed further light on any performance effects, and to specifically inform on possible differences in the reliance on more or less working memory dependent (rule-based versus associative) strategies between the goal states in question. It will be concluded that mastery-approach pursuit, relative to performance-approach, relies more upon working memory resources specifically for successful performance on high working memory demand tasks. However, it will also be concluded that performance-approach pursuit suffers less under high secondary load because of this goal states adaptive reliance upon less working memory demanding task strategies.

Study 5 (Chapter 6): With the aim of moving beyond just gross measures of performance and to more specifically and objectively explore working memory dependent task strategies, a category-learning paradigm will be employed in this final study. Specifically, using a single task design, investigation of the influence of achievement goal states on an information-integration categorisation task is presented. It will be concluded that experimentally manipulated achievement goal states failed to exert an influence on category-learning. It was found however that both trait mastery-approach and self-reported state performance-approach shared distinct patterns of relations to information-integration performance.

CHAPTER 2

Study 1

Overview of Meta-Analytic Chapter

The current chapter will address the issues surrounding the experimental manipulation of achievement goal states in order to inform the forthcoming experimental work in the current thesis. This will be achieved by conducting a quantitative review, a meta-analysis, of the literature with the key objectives of 1) identifying an effective method of experimentally inducing state achievement goals, 2) identifying an effective approach to conducting manipulation checks of such manipulated states, and 3) identifying what role study characteristics might play in influencing points 1 & 2. Findings will inform the manipulation method, manipulation check methods and study characteristics of the forthcoming experimental work presented in chapters 3 to 6. The current chapter will begin with a background review of state achievement goal manipulation methodologies. It will then progress to discuss the variability in such methodologies and issues surrounding the importance and need for the present quantitative review in order to progress competently to addressing the experimental aims of the current thesis. The meta-analytic procedure and findings will then be presented and finally discussed in line with how they have informed the experimental designs within the current thesis.

Background Review of the State Achievement Goal Literature

Much of the interest in understanding and describing the effects of achievement motivation on performance outcomes, including cognitive performance, has involved the experimental manipulation of motivational states. That is, rather than measuring goal orientations as individual differences variables, or self-reported situation specific achievement goals, researchers have manipulated achievement goals by various cues, settings and instructions which lead to the adoption of either an approach or avoidance form of a mastery or performance goal state focus. There is an abundance of research attending to achievement goal states which has confirmed the distinction between trait and state forms of achievement motivation foci (Chen et al., 2000; Ward et al., 2004), and that both independent and combined trait and state based approaches to studying achievement goals are viable (Chen & Mathieu, 2008; DeShon & Gillespie, 2005). For example, researchers have shown that trait mastery-approach and state mastery-approach, within the same study sample, uniquely influenced participants' reporting of self-efficacy (Kozlowski et al., 2001). Furthermore, overall, distinct patterns of relations for achievement goal states have been consistent with findings based on dispositional measures of goal orientation (Button et al., 1996; Kozlowski et al., 2001).

A multitude of contexts have entertained these manipulations. Although the laboratory has served as a rigorous setting for examining differential effects between these states and task performance (Kozlowski et al., 2001), the classroom (Church et al., 2001), sports field (Bernier & Fournier, 2010), and workplace (Martocchio, 1994), have also proven valuable in examining state achievement goals. As such, within the state achievement goal literature sample demographics have varied substantially, from primary school children, to undergraduates, to salespersons, to golfers, with some studies recruiting only females (Smith, Sansone, & White, 2007) and some recruiting only undergraduate psychology students (Barron & Harackiewicz, 2001) for example. There is also huge variability in the design of state achievement goal studies, including manipulation of just one achievement goal state, in comparison to a control (Church et al., 2001), up to a full four factor framework (Van Yperen et al., 2009). Although some studies have not employed a control group in addition to goal state conditions (Elliot & Harackiewicz, 1996), others have, most commonly involving either a ‘do your best’ goal assignment (Seijts, Latham, Tasa, & Latham, 2004), or assignment of no goal at all with the provision of only standard task instructions (Poortvliet et al., 2007). Group based manipulations have also been used (Darnon, Butera, & Harackiewicz, 2007) although individual manipulation is much more typical. Some researchers have manipulated multifaceted state achievement goals, for example, framing a task with a mastery-approach purpose but then assigning a performance-approach goal target (Kozlowski & Bell, 2006), or, assigning a mastery-approach goal frame but then providing the opportunity for participants to seek normative (performance-approach based) feedback (Chen & Mathieu, 2008).

Manipulation Method

Perhaps one of the most interesting areas of variability is in the manipulation methods employed to manipulate achievement goal states (see table 2.1 for examples of all the manipulation methods actually investigated in the current meta-analysis). These have included the manipulation of feedback frames (Chen & Mathieu, 2008; Steele-Johnson et al., 1993), aim or goal target frames (Poortvliet et al., 2007; Senko & Harackiewicz, 2002; Van Yperen et al., 2009), perceptions of ability (Steele-Johnson et al., 2000), standards of evaluation or grading systems (Harackiewicz et al., 1984; Church et al., 2001), task purpose instructions (Barron & Harackiewicz, 2001; Elliot et al., 2005), error framing (Bell & Kozlowski, 2008), experimenter presence (Spinath & Stiensmeier-Pelster, 2003) and rewards (Harackiewicz et al., 1984; Steele-Johnson, Heintz, & Miller, 2008). Often, methods are used in combination to manipulate goal states, for example, task purpose instructions are teamed with goal

Table 2.1. Examples For Each of the Manipulation Methods Investigated in the Current Study

Manipulation Method	Mastery-Approach	Performance-Approach
Goal frame	"Perform better on your second ranking as compared to your first ranking" (*Poortvliet et al., 2007*)	"Perform better on your second ranking as compared to the other's ranking" (*Poortvliet et al., 2007*)
Feedback frame	Participants are given outcome feedback on the number of errors made in a just completed task round and additional learning feedback information regarding how to avoid specific errors in future performance. (*Steele-Johnson et al., 2003*)	Participants are given outcome feedback on the number of errors made in a just completed task round with no additional instructional information, but are told that they may wish to review their performance approach before starting the next round. (*Steele-Johnson et al., 2003*)
Task purpose	"What we are interested in is how students develop their pinball skills on our pinball machines. We're getting students with different levels of pinball experience and collecting data on how they learn to play and improve on our Jungle King machine." (*Harackiewicz & Elliot, 1993*)	"What we are interested in is how well some students play pinball compared to others. We're getting students with different levels of pinball experience and collecting data on how well they play compared to others." (*Harackiewicz & Elliot, 1993*)
Task purpose and goal frame	"The purpose of this study is to collect data on college students' reactions to this game." Your objective is to "learn how to play this game well." (*Elliot et al., 2005*)	"The purpose of this study is to compare college students with one another in their ability to solve these puzzles." Your objective is to "demonstrate that you are an exceptional puzzle solver" (*Elliot et al., 2005*)
Perception of ability	Task instructions were designed to create the perception that cognitive ability is changeable and easy to improve through effort and to focus the participants on exploring and mastering the task. (*Steele-Johnson et al., 2000*)	Task instructions were designed to create the perception that cognitive ability was stable and difficult to improve through effort and to focus the subject on achievement (i.e., scoring well). (*Steele-Johnson et al., 2000*)
Task purpose and feedback frame	This research is interested in the process you follow in completing the simulation. Note that in addition to your score, this program will keep track of the information you collect as well as the individual decisions that you make. This research is interested in the process you use to make those decisions and, on completion of the simulation, you may be asked to justify the process you used to make decisions during the simulation. (*Davis, Mero & Goodman, 2007*)	Participants were told that the problems they would be working on were designed to assess intelligence and that the experimenter would be comparing their performance to that of other students (*Jagacinski, Kumar & Kokkinou, 2008*)

Table 2.1. Continued

Manipulation Method	Mastery-Approach	Performance-Approach
Task purpose and goal frame and feedback frame	Participants were told that the task had been designed to examine how a person's skill of concentrating on a given task develops over time. The goal would be to find out to which extent one would be able to improve one's performance during the course of the experiment. Next, they were told that after each block of trials, they would receive feedback indicating whether they had (or had not) reached a "top performance." The experimenter stated that the term "top performance" would be used to denote "that you have surpassed at a given block the best performance you have reached on any of the previous blocks." (*Brunstein & Maier, 2005*)	Participants were told that the experimental task had been designed to test individual differences in people's ability to concentrate on a given task. The goal would be to find out if one would be able to meet a level of performance characteristic of high-achieving students. For this purpose, participants would receive feedback after each test block. Participants were advised that the term top performance would be used to signify "that the level of performance you have reached on a given block is among the upper third of achievements other students have reached on that block." (*Brunstein & Maier, 2005*).
Task purpose and perception of ability	Instructions emphasised that the experiment was concerned with participants problem solving styles and approaches, and not about ability, i.e. wasn't interested in how many number of correct answers achieved. (*Lawrence & Crocker, 2009*)	Participants read that the study would be conducted to test students' ability to concentrate. Furthermore, they read that numerous students would have to terminate their course of studies without a degree and that, according to recent research, the main reason for these failures would be their inability to concentrate. Thus, performing well ostensibly indicated an ability that was important for academic success. (*Gendolla & Richter, 2005*)
Goal frame and feedback	"We recommend that you adopt a specific goal when completing this task, to do better than your total score in the previous round". Participants were informed that they would be told their ongoing scores after each task trial. (*Van Yperen et al., 2009*)	"We recommend that you adopt a specific goal when completing this task, to do better than the average total score in your norm group". Participants were informed that they would be told their ongoing scores (relative to norm) after each task trial. (*Van Yperen et al., 2009*)

frames to produce a multidimensional manipulation method (e.g., state performance-approach: "*These puzzles are an opportunity for you to see how well you can perform compared to other students. Therefore, we recommend that you adopt a "performance goal" for the next puzzle. Achieving this performance goal involves finding more* *words than other participants in the next puzzle*.", Senko & Harackiewicz, 2005a). An objective of the current meta-analytic investigation is to examine whether effect sizes associated with manipulation are influenced by the actual method of manipulation employed.

Manipulation Check Type

Manipulation checks are another key feature of state achievement goal studies. Some researchers don't employ any kind of manipulation check procedure (Spinath & Stiensmeier-Pelster, 2003) which clearly raises some concern as to the extent to which any task performance differences can actually be attributed to the assumed manipulated achievement goal states. When manipulation checks are employed, there are two common ways of doing so. The first is to measure participants understanding of, or attentiveness to, the manipulation method (Goal Recall). For example, Elliot et al. (2005) employing a combined task purpose instruction (e.g., state performance-approach: "*This is an opportunity to demonstrate that you are an exceptional problem solver*"), and perceptions of evaluation (state performance-approach: "*You will be informed at the end of the task, whether you did well in comparison to others*") manipulation method prior to engagement in a cognitive ability task, then, presented participants post-task with the question, "*What was the goal that you were given for this task*?" and participants were required to respond by ticking one of three listed options which restated the instructed manipulations (e.g., state performance-approach: "*to demonstrate that I am an exceptionally good problem solver*"). Clearly this manipulation check attends specifically only to the task purpose element of the combined manipulation method, but, confirms whether participants were clear on what their assigned condition was. In addition to 'tick box' responses, other response methods to these Goal Recall checks include open ended responses (Elliot & Harackiewicz, 1996), likert responses (Davis et al., 2007), and participants' own words (Stevens & Gist, 1997).

The second approach is to measure, mostly via questionnaires, the extent to which a manipulation had a desired effect on participants' psychological state, that is, whether participants report actually being in an achievement goal state (Goal State). For example, when examining the role of state achievement goals in working memory functioning using a goal frame based manipulation method, Linnenbrink et al. (1999) presented participants post-task with an adapted form of the Patterns of Adaptive Learning Survey (Midgley, Maehr, Hicks, Roeser, Urdan, Anderman, & Kaplan, 1996). This scale measured, using a likert scale response, participants experience of achievement goal states whilst completing the task (e.g., state mastery-approach: "*As I completed the working memory task, I focused on improving my score*"). Typically, all participants complete all items corresponding to all state achievement goal conditions regardless of their assigned condition, with the aim of those for example, manipulated into a mastery-approach state, reporting a heightened experience of this state in comparison to participants assigned to other conditions. Alternatives to the reliance upon questionnaires in examining Goal State have include self-reported skill-maintenance during activity (Gist & Stevens, 1998) and experimenter observation of behaviour (Bernier & Fournier, 2010), for example.

Disappointingly, although the questionnaires employed in this just described Goal State approach aim to address the same construct, achievement goal states, they do vary somewhat. For example, measures are often adapted trait achievement goal scales (Jagacinski et al., 2008), making results difficult to compare across different studies, and raising the potential concern of 'cherry-picking' of items to maximise observed effects (Darnon et al., 2007). Additionally, rather than relying upon pre-existing, validated measures here, some authors develop their own items to assess Goal State (Thompson & Musket, 2005), presenting further issues in terms of construct validity and comparability between different studies. A key aim of the current meta-analytic investigation is to address whether effect sizes associated with manipulation vary as a function of type of manipulation check used.

Study Characteristics

In more specifically considering the procedures surrounding these checks, some studies have employed a Goal Recall and a Goal State check approach, often one straight after the other, to confirm manipulation effectiveness (e.g., Steele-Johnson et al., 2008). Both of these manipulation check approaches are also identifiable at different stages of an experimental procedure across studies. Most commonly, these checks are taken post-task, immediately after a participant has completed an activity under manipulation (e.g., Elliot et al., 2005). In some cases, checks are conducted immediately after manipulation but prior to any task engagement (e.g., Elliot & Harackiewicz, 1996), or after a practice or training session but before actual task engagement (e.g., Loraasa & Diazb, 2009). These manipulation check approaches have also been positioned at different points to each other and both have also been used at multiple points within the same experimental procedure to capture any changes in manipulation effectiveness (e.g., Spinath & Stiensmeier-Pelster, 2003). There are even examples of researchers conducting manipulation checks on a preliminary pilot sample of participants to validate the use of a manipulation method, rather than in the main study reported (e.g., Darnon et al., 2007).

Similarly, the timing of when states are actually manipulated during an experimental procedure also presents itself as a point of interest. Manipulations typically take place immediately prior to task engagement (Covington & Omelich, 1984), with others more evidently embedded within the presentation of initial task instructions (Kozlowski et al., 2001), however, some researchers position their manipulations following a practice or task training session (Van Yperen et al., 2009). Of course, if a multidimensional method is being employed, then manipulation can occur at multiple points of the experimental procedure (Elliot & Harackiewicz, 1994). The delivery method of manipulations has also been particularly mixed, including verbally by an experimenter (Grieve, Whelan, Kottke, & Meyers, 1994), via an auditory taped played over headphones (Senko & Harackiewicz, 2005a), and read directly by the participant (Elliot & Harackiewicz, 1996).

Use of manipulation prompts has also fluctuated across studies, for example, some researchers who employed a goal target frame manipulation method ("*your goal is to achieve…*") presented at the start of task engagement, then also present participants with a reminder of their goal prior to each task block. This is mostly done either verbally by an experimenter or by a written reminder (Kozlowski & Bell, 2006), but also evident in the literature is the use of goal 'check lists' or 'scoring sheets' which participants are directed to between experimental blocks (Elliot & Harackiewicz, 1994). Overall these prompting procedures ensure that the primary manipulation method is reinforced throughout the intended manipulation period. Other aspects of state achievement goal studies which have varied include experimenter blindness to goal conditions (Elliot et al., 2005), measurement and accounting for trait goal orientation (Davis et al., 2007), and the inclusion of other manipulated constructs along side state achievement goals such as goal difficulty (Winters & Latham, 1996) or the use of different task stimuli including atypical and typical words to be remembered on a recall task for example (Escribe & Huet, 2005). Finally, assignment to experimental condition is often random (Mangos & Steele-Johnson, 2001) but has also been performed according to scores on other variables, such as trait goal orientation (Escribe & Huet, 2005).

A Necessary and Overdue Methodological Review

Such variety within the literature is valuable in the sense of exploring and understanding the potential impact and generalisabilty of state achievement goal effects, but it also raises some concerns: To what extent do methodological inconsistencies contribute to inconsistent findings across studies? What is the most effective means to manipulate achievement goals? Do certain types of checks used to validate manipulation effectiveness inflate effects? What study characteristics might contribute to the detection of between group effects?

To the author's knowledge, two previous meta-analytic studies have been conducted which specifically examined state achievement goals. Utman (1997) meta-analysed twenty-four studies involving the experimental manipulation of achievement goals finding overall that mastery-approach goals lead to better task performance than performance based goals, but that this advantage was limited to complex tasks. It was specifically predicted in Utman's meta-study that the advantage of state mastery-approach goals would be even larger when state performance-approach goals are manipulated in a particularly highly pressured manner, which was partially supported, and when mastery-approach goals are based upon a manipulation approach which is highly self-referential, which was not supported. Furthermore, Utman (1997) predicted, and found, that state effects are larger when those in a state of mastery-approach are tested alone and when those in a performance based state are tested in the presence of co-participants. In the second meta-study, Rawsthrone and Elliot (1999) meta-analysed thirty studies, finding that manipulated performance based goals undermined intrinsic motivation compared with state mastery-approach goals, most notably when performance-avoid goals were manipulated combined with positive competence confirming feedback.

Both of these meta-studies conducted in the earlier state achievement goal literature demonstrated that aspects of manipulation design influence findings. Since these studies, as evidence by the more recently discussed and referenced research in this chapter so far, further variability is evident in the increasingly evolving state achievement goal literature (see figure 2.1 for the frequency of studies published between 1997 and 2009, retrieved in the initial searches conducted for the current meta-study; 1997 being when the first (Utman, 1997) meta-analysis was conducted, and 2009 being when the current study was conducted). Yet, little to no effort has been invested by researchers to account for or attempt to investigate the role manipulation methods might play in understanding effects. Issues of validity therefore become very apparent, particularly concerning the adequacy of a manipulation method in actually instigating state achievement goal co-variation. Within other areas of psychological research, such as mood manipulation procedures, meta-analyses have proved hugely valuable in unearthing what methods are most effective at inducing desired states, and what factors influence the direction and magnitude of effects (Larsen & Sinnett, 1991; Westermann, Spies, Stahl, & Hesse, 1996). Now, more than 10 years since these previous state achievement goal meta-studies were conducted, there is arguably a call for the need to conduct a more thorough review of this literature.

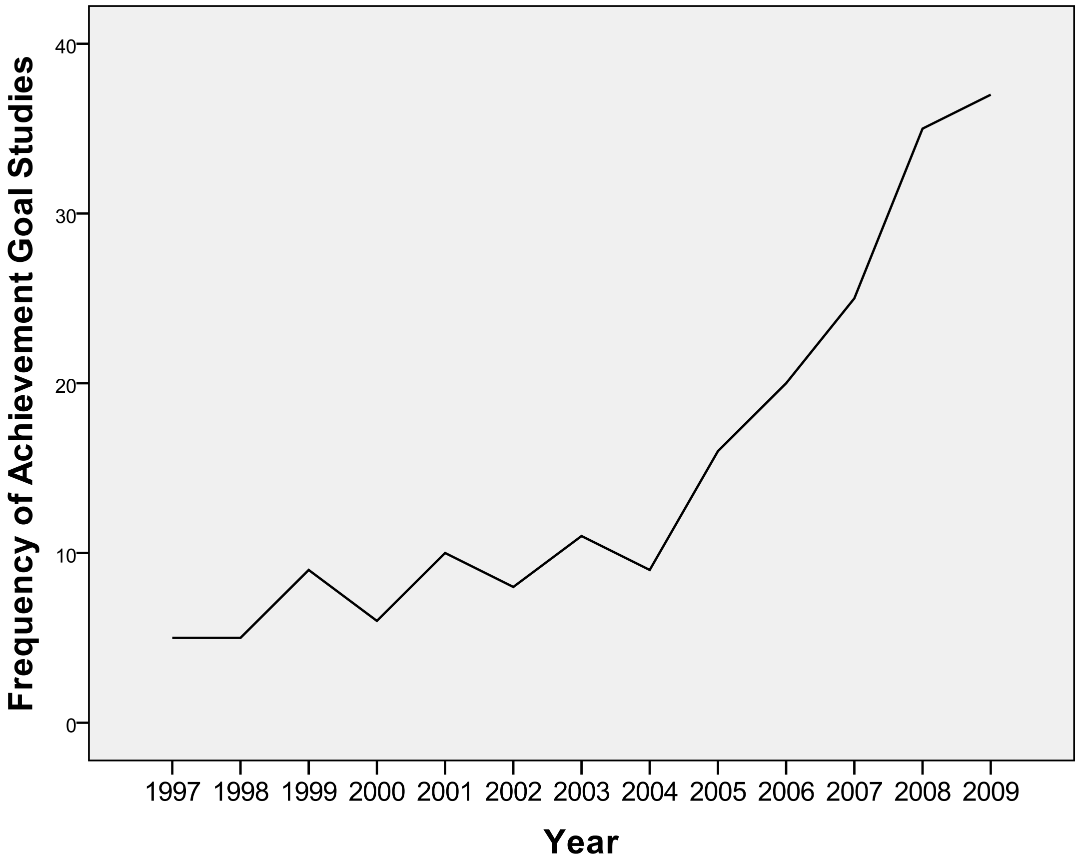

Figure 2.1. Frequency of achievement goal studies since meta-analyses conducted in the late 1990's up until the current meta-study. Frequencies are based on retrievals from initial searches conducted for the current meta-analysis.

In line with the current thesis aims, much of the aforementioned variability is evident across studies that have addressed the relations between state achievement goals and cognition. For example, in investigating state goal effects on strategy maintenance, Escribe and Huet (2005) used different methods to manipulate different goal states within the same experiment, using a single task purpose frame to manipulate mastery-approach ("*this task is a means of developing your own competence*"), however a combined task purpose frame with the addition of perceptions of normative evaluation ("*at the end of the experiment we will tell you what your level is and how well you compared to others*"). Those in the mastery-approach condition were provided with no information on possible self-referential evaluation. These authors went on to conclude that mastery-approach results in superior maintenance of complex learning strategies relative to performance-approach pursuit, but unfortunately included no manipulation checks. One has to question whether the same pattern of results would have been found if the mastery-approach manipulation method also included references to self-referential evaluation (e.g., achieving above a personal best/previously achieved score).

Intriguingly, Murayama and Elliot (2011) found using simple task purpose frame manipulation methods (*opportunity to develop or demonstrate skill*), and on the basis of significant manipulation checks, that on a recognition task both performance-approach and mastery-approach related to forms of elaborative processing. The manipulation checks employed here were single (authors own) Goal Recall items for each goal state, positioned in between two testing blocks (i.e., during task performance). Steele-Johnson et al. (2000) however found a performance-approach overall task performance advantage, relative to mastery-approach, on a cognitive scheduling task through the use of ability based manipulation methods by telling those in the performance-approach condition that ability is stable and difficult to improve, but told those in the mastery-approach condition that ability is changeable and can be improved through effort. These authors confirmed effective manipulation through the use of their own multiple item Goal State checks, but positioned these immediately after manipulation (i.e., prior to task engagement). Moreover, Chen and Mathieu (2008) found no direct effect for mastery-approach or performance-approach, manipulated using a combined task purpose and goal frame method, on working memory task performance. Although Chen and Mathieu (2008) report that their manipulation method was valid, such speculation was based upon a pilot study in which the manipulations were trialled, not on the actual main experimental sample.

Graham and Golan (1991) and Barker et al. (2002) both examined the influence of state achievement goals on immediate recall of information processed at shallow and deep levels, but found some incompatible results. Specifically, Graham and Golan (1991) manipulated state mastery-approach and performance-approach in addition to a control group receiving only standard instructions, and found no word recall differences between groups under shallow levels of processing, but found that state performance-approach resulted in poorer word recall under deeper levels of processing than mastery-approach. In contrast, Barker et al. (2002) induced the same goal framework, and found that state performance-approach resulted in superior recall of deeply processed information relative to a mastery-approach goal or control group.

Importantly, there were some key differences in the design of these two studies. Although both studies used goal frame based manipulation methods which presented participants with an instruction regarding the focal aim required for an experimental task (e.g., state mastery-approach: "*If you concentrate on this task, try to see it as a challenge and enjoy mastering it, you will probably get better as you go along*."), Graham and Golan (1991) positioned their manipulation between an initial practice phase of an unrelated puzzle task and a main computerised experimental task so that their goal frame manipulation method could make specific reference to participants' perceptions of their performance on the initial practice phase (e.g., state mastery-approach: "*Many people make mistakes on these puzzles in the beginning but get better as they go along. When people see the puzzles as a challenge, it makes them try harder and have more fun along the way. The next activity is a lot like this one*."). However, Barker et al. (2002), with the aim of making a more believable manipulation context, rather than using an initial puzzle phase, used an initial experimental protocol which was identical to the main experiment, separated by 24 hours. That is, the day before the main experiment participants completed a training phase of the main experiment under goal frame manipulation. When participants returned the next day to run through the main version of the experiment, the researchers re-ran the manipulation method again, just prior to task-engagement - the researchers suggested that the salience of the manipulation in the main experiment would be enhanced as such.

Barker et al. (2002) additionally employed motivational prompts throughout the main experimental phase by repeating assigned goal frames after task-engagement just before any recall tests were administered. These authors conducted their research in the active classrooms of the children involved, in contrast to Graham and Golan (1991) who used less realistic unoccupied classrooms. Interestingly, Barker et al. (2002) actually proposed that these modifications, in comparison to Graham and Golan (1991), were done so with the aim of making the manipulation of goal states more effective. Although the key difference between these researchers task performance findings were based around the direction of effects, i.e., advantages for a particular goal state, which will not be specifically addressed in the current meta-analytic investigation as will be explained later in this chapter, presentation of the variability between the design aspects of these two studies highlights the potential of how timing of manipulation and manipulation prompting in particular could influence effects.

In terms of manipulation checks, Graham and Golan (1991) conducted post-task Goal Recall manipulation checks using open choice responses, which confirmed that participants' perceptions of performance on the main experimental task corresponded to their assigned condition. However, Barker et al. (2002) included no assessment of the effectiveness of their manipulation. This raises the question as to whether the observed inconsistent effects to those of Graham and Golan (1991) found by Barker et al. (2002) might actually be explained by issues relating to effective manipulation.

The limited number of studies which explicitly address working memory and state achievement goals, also demonstrate the extent to which use of manipulation checks can contribute to findings. For example, Linnenbrink et al. (1999) and Parkes et al. (1998) both examined state mastery-approach and performance-approach influences on working memory capacity. Both studies used goal frame based manipulation methods immediately prior to capacity task engagement. Unfortunately, Linnenbrink et al. (1999) author own constructed Goal State post-task manipulation checks revealed their manipulation not to have been effective and these researchers could not continue to examine experimentally manipulated group differences. In contrast, Parkes et al. (1998) included no manipulation checks within their study and went on to conclude that only state mastery-approach is related to higher working memory capacity scores. This highlights the potential for exclusion of manipulation checks to result in potentially unreliable inferences regarding experimentally manipulated state achievement goals. But more importantly for the current meta-analytic investigation, it also brings attention to the possibility that the type of manipulation check used might play an important role in detecting manipulation effectiveness. Importantly here, Linnenbrink et al. (1999) included within their performance-approach instructional goal frame, an additional reference to evaluation standards/perception of ability ("*I will be ranking you based on your ability to complete the tasks…..*"). It is difficult to suggest that this modified, multidimensional manipulation method (relative to that used for mastery-approach) might have contributed to the lack of manipulation effectiveness and issues discussed in the previous paragraph. But, this point highlights the need for clarity on manipulation methodology effectiveness.

The current study sets out to assess and compare the effects of state achievement goal manipulations. There are two main aims to be addressed in this chapter; to what extent do manipulation methods, manipulation checks and study characteristics contribute to the effectiveness of experimental manipulation, i.e., manipulation strength, and secondly, to state achievement goal task performance effects, i.e., the impact of manipulation. As Meehl (1978) proposed, concerns over the auxiliary conditions of an experiment are imperative if one is to understand whether effects found, or not, may be because conditions of an experimental procedure don't sufficiently represent an adequate application of a manipulation. This is central to the current meta-study, as investigating whether specific procedural conditions compromise or facilitate the validity of a manipulation, and performance effects, will specifically inform the manipulation methods, manipulation check procedure, and other features to be included or excluded from the design of the experimental work presented in chapters 3 to 6 within the current thesis. This is why it was decided that the current meta-analytic investigation would specifically focus on only two factors of a possible four factor state achievement goal framework, the two that will actually be examined in chapters 3 to 6, that of mastery-approach and performance-approach. Further discussion of this decision is provided in the inclusion criteria subsection of this current chapter. The current investigation aims to document the extent to which state achievement goal study features contribute to the magnitude of manipulation check and task performance effects (i.e., whether such features contribute to the likelihood of observing a difference between experimental groups) and is less concerned with the direction of such effects (i.e., whether such features contribute to the likelihood of observing an advantage or disadvantage for a particular experimental group).

Most of the investigation in the current chapter will be exploratory given that specific predictions regarding each manipulation method, manipulation check and associated study feature is too ambitious given the lack of any previous investigation within the literature. Also, it is difficult to ascertain at this stage which exact methods, checks and characteristics will be present in a final set of effect sizes once studies from the literature have been filtered through inclusion criteria. Nevertheless, based on the presented discussion so far in this chapter, three main hypotheses are presented:

1) Method of Manipulation will influence variability in manipulation check and task performance effects.
2) The type of manipulation check employed will influence variability in manipulation check effects, i.e., will moderate manipulation effectiveness.
3) Study characteristics, such as manipulation prompting and timing of manipulation, will explain variability in manipulation check and task performance effects.

Method

Literature Search

A comprehensive literature review was conducted to identify published studies containing experimental manipulation of state achievement goals. Primarily, a computerised search of databases PsycINFO, Web of Science, Social Sciences Citation Index, and Sciencedirect, in all domains was conducted. Searches included combinations of the following keywords; achievement goals, goal orientation, mastery (approach), performance (approach), task-involved, ego-involved, state, manipulation, manipulation check, goal condition. These searches were restricted to start from the year 1984 in accordance with the introduction of the achievement goal construct by Nicholls (1984), including studies up until the end of 2009 when this meta-study was conducted. Then, reference sections specifically of previous state achievement goal meta-studies were searched to identify studies. Following this, key researchers within the field were contacted to identify any relevant studies which might be in progress or under review. Finally, the reference section of all studies retrieved from these steps were searched to identify any further relevant studies. In total, these searches yielded approximately 225 studies from sources including peer-reviewed journal articles and book chapters.

Abstracts of all hits were read and evaluated according to relevance. Full text copies of studies were obtained of those deemed relevant to meta-analytic review, either by electronic download using links via Goldsmiths, University of London Library online E-Resources, or, via Senate House Library eResources and eJournals Catalogue. If studies were not available to download electronically, then print copies were ordered via the British Library. Alternatively, authors were emailed directly to request copies.

Inclusion Criteria

The criteria upon which studies were deemed relevant for inclusion in the current meta-analytic investigation were set specifically in mind of this investigations purpose of informing the experimental work of the current thesis. What follows here is a list of such criteria with explanations, where appropriate and necessary, of why such decisions of inclusion, or indeed exclusion, were made.

Criteria for study inclusion decisions were that:

- It included an experimental manipulation of either a mastery-approach (MAP) and/or performance-approach (PAP) state achievement goal in comparison to each other, or, in comparison to a control group (Control). The current investigation was specifically restricted to the approach forms of a mastery and performance goal state for two main reasons. Firstly, these are the two specific achievement goal states, from a possible four factor framework, that will be manipulated in the experimental work of the current thesis (such selection will be further discussed in chapter 4). Secondly, much of the research which has experimentally manipulated achievement goals as states has only incorporated these two states specifically, meaning that the bulk of available data to be meta-analysed is for these two approach states relative to their 'avoidance' based counterparts. Furthermore, inclusion of studies which compared either, or both, a MAP or PAP state to a Control group was deemed important, as including only studies which compared the two main achievement goal states to each other would potentially result in exclusion of valuable and meaningful data.
- It included a manipulation check of experimental manipulation and/or objective task performance data comparable for experimental conditions.
- Manipulation is based on a between-subjects design. This was set firstly given that all experiments within the current thesis will employ a between-subjects design and thus meta-study findings needed to specifically inform on such designs. Secondly, within-subject based manipulations confound state achievement goals with each other

meaning that it is difficult to separate the effectiveness of states manipulated and the impact of states on task performance.

- If an experimental design employed within-subject manipulations, but still actually provided relevant and suitable data for inclusion, it was coded. For example, if achievement goal states were manipulated within subjects, but a manipulation check of the first manipulated state (e.g., MAP) had been conducted before the second state was manipulated (e.g., PAP) (e.g., Chen & Mathieu, 2008) then there was an opportunity to extract a non-confounded manipulation check effect size.
- Manipulation was individually based, not at a group level. This was set given that experimental manipulations within the current thesis would be at an individual level.
- The sample receiving manipulations were healthy adults (thus excluding child, adolescent and clinical samples). This was set given that the experimental aims of the current thesis would be addressed using samples of healthy adults and thus application of meta-analytic findings needed to be constant with such a sample.
- It is published in a peer-reviewed journal. In addition to the fact that this would act as a quality control process, this was set primarily given that little funding was available to cover the financial expense that accessing unpublished studies would incur. But also, because forthcoming experimental work depended on current meta-analytic findings, the delay in starting analyses that sourcing and receiving unpublished work would incur was deemed damaging. It is recognised that such publication bias does inflate the risk of Type 1 error, i.e., successful manipulation,

however, given that this would be the case for all manipulation methods and procedures it was deemed that findings regarding differences in the effectives of different manipulation methods, manipulation checks and the influence of study characteristics on effects, could still be achieved without major cause for concern.

- Available in the English language. This was set given that no funding was available to cover the financial expense that translation of studies would incur.
- The study contains the minimum necessary statistical information for the estimation of a group comparison based effect size.
- If a paper contained more than one independent experiment, it contributed multiple, independent, effect sizes.
- Given that addressing the present study aims will involve that separate meta-analytic analyses are run for manipulation check data, and for task performance data, if a single study provided both manipulation check and task performance data, both were coded as even though both are based on the same sample of participants, these effect sizes would be analysed independently.
- If studies crossed state achievement goals with other motivational manipulations designed to affect task performance (e.g., use of different task stimuli including atypical and typical words to be remembered on a recall task; Escribe & Huet, 2005) then caution was taken. Rather than unnecessarily excluding data, separate effect sizes were calculated for each group formed by the assignment of participants to levels of the other non achievement goal variable.

- For relevant studies which used multiple measures of task performance (e.g., multiple task blocks), effect sizes were calculated for each measure and then averaged, resulting in one contributing effect size.
- For studies which reported that there were no significant effect(s) found with no statistical information provided, an effect size of 0 was assigned. Although it is noted this has a tendency of compromising overall effects, it was deemed more important to still include this study given the central focus of understanding the effectives of manipulation features.

Coding and Effect Size

The current thesis author (Rachel Avery) independently coded each study. Decisions regarding the coding of ambiguous cases were aided by discussion with experts in meta-analysis on the faculty at Goldsmiths, University of London. The standardised mean difference between two comparison groups formed the focus of the current study, i.e., the *d* statistic (Cohen, 1988; Hedges & Olkin, 1985) was used. Effect sizes were computed using means and pooled standard deviations. When these were not reported, complete *t* and *F* statistics were converted, and when these were not reported, exact or categorical *p* values or correlations were converted to effects sizes (Rosenthal & Rosnow, 1991). When no statistical information is provided but it is stated in a study report that no significant effect was found, zero effect sizes were assumed. Thus, *d* represented a standardised unbiased estimate of the mean difference between two experimental groups in question.

It is important to note that most studies report multiple manipulation check results for the same group comparison. For example, if a study manipulates MAP and PAP, and employs a Goal State questionnaire based check of manipulation, it often does so using a measure containing both state mastery-approach and performance-approach items. Manipulation check analyses will therefore compare these two state conditions on both sets of items, resulting in two manipulation check effect sizes from the same comparison. Also, such a study in addition to a Goal State check may have also used another, Goal Recall manipulation check, resulting in multiple manipulation check effect sizes for the same comparison. Although including all these effects in the same analyses introduces statistical bias by violating assumptions of independence (Glass, McGaw, & Smith, 1981), it was decided given the centrality of investigating different manipulation check procedures to the current chapter hypotheses, that the information lost with the aim of avoiding statistical dependence here would even further bias and limit results, and so all manipulation check effects per comparison were coded[1]. For example, if all such effects were combined and then averaged or if one effect was selected over another, one would then weaken the investigation of different manipulation check procedures. This approach of inclusion despite statistical bias is evident amongst other meta-analysts who have investigated manipulation check data and when avoidance of statistical dependence would seriously limit investigation of study hypotheses (e.g., Larsen & Sinnett, 1991).

Furthermore, if there are more than two state experimental conditions being compared, for example, a study manipulates MAP, PAP, and a Control group, and all three conditions are compared to each other, then again, more than one set of manipulation check effect sizes per comparison are presented. However, given that

[1] The only exception here was if a study used the exact same manipulation check more than once for the same comparison, for example, the same check at multiple time points within an experimental procedure (time 1, time 2 etc.). In such a case effect sizes were calculated and then averaged to produce one contributing effect size. Only one study, Spinath and Stiensmeier-Pelster (2003), was identified to present such data.

separate analyses will be run per comparison being made (e.g., for MAP and PAP, and MAP and Control), coding all such data did not present any dependency issue.

There are two major themes of analysis here, firstly, to examine manipulation check effect sizes, and task performance effect sizes as dependent variables. Secondly, to then examine manipulation methodology, manipulation check type and various other study characteristics as moderator variables, conducting separate analyses for different experimental condition comparisons. A coding system was specifically devised to capture such potential moderator variables. It is necessary to make clear that the levels of the moderator variables about to be outlined are specifically determined by what design aspects were actually present or detailed in the final set of included studies. That is, although as outlined in the background review of this chapter, there is ample variability within the literature, obviously the extent of variability to be addresses in the current meta-analytic investigation is limited by the actual design aspects employed within the final set of included studies[2]. Group comparisons per experiment were coded on the following dimensions (If an experiment provided both manipulation check data, and task performance data, then both were coded on the dimensions below. However, if an experiment only presented either manipulation check or task performance data, then only the relevant dimensions below were coded, e.g., manipulation check type would not be coded for experiments in which only task performance data was available):

- MANIPULATION METHOD. Goal frame; Feedback frame; Task purpose; Task purpose and goal frame; Perception of ability; Task purpose and goal frame and feedback frame; Task purpose and feedback frame; Task purpose

[2] Study characteristics of particular interest which had to be discarded because of few entries included assignment to conditions, type of control group used, and type of manipulation prompting used.

and perception of ability; Goal frame and feedback. (See table 2.1 for examples of each of these manipulation methods)

- MANIPULATION CHECK TYPE. Goal Recall check; Authors own Goal State check; Standard Goal State check; Self-reported skill activity.
- MANIPULATION TIMING. Prior to task engagement; Following a training or practice phase; Multiple points as a multidimensional manipulation was employed and dimensions manipulated at different stages.
- MANIPULATION DELIVERY METHOD. Via headphones to participant; Verbally by experimenter; Read by participant himself/herself.
- MANIPULATION PROMPTING. Yes; No.
- EXPERIMENTER BLINDNESS. Yes; No.
- MANIPULATION CHECK TIMING. Immediately following manipulation thus prior to task engagement; Following a practice or training phase; Post-task.

Meta-Analytic Strategy

Due to the upward bias in effect sizes when based on small sample sizes, once effect sizes were coded, the small sample bias correction was applied (Hedges, 1981). Effect sizes were then categorised into sub-groups in order to ensure groups of statistically independent effect sizes, relevant group comparisons, and to arrange effect sizes ready for analysis according to chapter hypotheses. It became clear at this point that the number of effect sizes available to specifically run separate meta-analyses comparing each goal state with a control group (i.e., MAP to Control, and PAP to Control) was limited. That is, for both manipulation check effect sizes and task performance effect sizes, it was planned to examine all three possible combinations of group comparisons according to current inclusion criteria (MAP to PAP, MAP to Control, PAP to Control). However, for example, only two effect sizes were deemed relevant for a MAP to Control comparison on manipulation check effect sizes (Darnon et al., 2007; Sage & Kavussanu, 2007). As such, it was decided that to ensure that such valuable data was not excluded, rather than analysing each goal state to a control separately, these were combined to produce one comparison thus one subgroup of effect sizes, i.e., State Achievement Goal (SGO) to Control. To ensure that assumptions of independence had not been violated by taking such described action, any study which had contributed an effect size to both original subgroups of comparison (MAP to Control, and PAP to Control), were averaged, thus only contributing one effect size to the final SGO to Control subgroup[3].

In sum, for both manipulation check effect sizes and task performance effect sizes, two subgroups were formed; a) MAP and PAP comparison, and b) SGO and Control comparison, producing a total of four independent[4] subgroups of effect sizes for meta-analysis. In both instances here the purpose is not to attempt to observe any particular advantage for either experimental group being compared (e.g., whether MAP is more successfully manipulated than PAP, or whether MAP has a task performance advantage over PAP), but rather to observe simply if manipulation methodology, manipulation check type and study characteristics, generally contribute to producing observable group differences in manipulation check and task performance data. Thus, to ensure that calculation of mean effect sizes are not confounded by this matter a positive *d* was not coded to represent a particular experimental group advantage, but rather, to represent an overall observed difference

[3] With the exception, as previously described and justified, of when multiple manipulation check data for the same comparison is available.
[4] Again, with the exception, as previously described and justified, of when multiple manipulation check data for the same comparison is available.

between experimental groups, i.e., identification of manipulation check or task performance differences[5,6].

All effect sizes were weighted by the inverse of the sampling error variance to ensure each effect size's contribution is proportionate to its reliability. Distributions of effect sizes were examined to determine the presence of any outliers of which none were identified which warranted removal or adjustment according to the procedure of Hedges and Olkin (1985). Hunter and Schmidt (1990b, 1994) specifically outline a variety of effect size adjustments which meta-analysts should make including adjustment for unreliability of variables involved in the effect size, for restrictions in the range of such variables, for dichotomization of continuous variables, and for imperfect construct validity. However within the included research in the current study, for example, reliability estimates of manipulation check procedures were often not reported in the research studies, in addition to the fact that reliability estimates for objective task performance data were often not relevant. Furthermore, the majority of task performance effect sizes were continuous in nature. Given the lack of consistency here it was deemed best to leave all effect sizes unadjusted on these four artefacts rather than adjust some and not others with the aim of keeping effect sizes more comparable.

Following this, weighted mean effect sizes for each subgroup and confidence intervals around such mean effect sizes were calculated. Confidence intervals were

[5] For example, an effect size of .335 (from Steele-Johnson et al., 2000) representing successful MAP manipulation, and an effect size of .404 (from Davis et al., 2007) representing successful PAP manipulation, were both included in the same effect size subgroup. Thus, a positive d didn't represent an advantgae for a particular group, but rather a between group difference. Thus, when coding and making note of what experimental groups were being compared (i.e. which mean is subtracted from the other before the difference is then divided by the pooled standard deviation), the experimental group noted to have achieved a successful manipulation or task performance advantage by the study author, was coded as the primary/treatment group.
[6] This was deemed even more important given that many of the studies from which task performance effect sizes were calculated, presented very different predictions in terms of whether there would be a MAP or PAP advantage across various different types of tasks.

based on the standard error of the mean in question and a critical value from the z-distribution which represents the desired confidence level. These are multiplied together added to the mean effect size to achieve an upper limit, and subtracted from the mean effect size to achieve a lower limit. For all current meta-analytic analyses, the desired confidence level was set at 95%. Any confidence intervals which included 0 were interpreted as a non-significant effect. Homogeneity analyses to address hypotheses were tested using the Q statistic, which is distributed as a chi-square with $k - 1$ degrees of freedom where k is the number of effect sizes (Hedges & Olkin, 1985). A significant Q was taken as indication of systematic variance among effect sizes highlighting the need for examination of moderator variables that may account for differences in the effect across studies. All effect sizes were coded using WILSON Effect Size Determination Program (2001) and analyses were performed in SPSS as outlined by Lipsey and Wilson (2001).

Results

Of the total 106 effect sizes[7] being analysed, 31 were included in the MAP and PAP manipulation check subgroup, 12 were included in the SGO and Control manipulation check subgroup, 36 were included in the MAP and PAP task performance subgroup, and 27 were included in the SGO and Control task performance subgroup. Frequency analyses of all effect sizes revealed that the most commonly used manipulation method, was a combined task purpose and goal frame method, but this still only accounted for 33% of effect sizes. Researchers favoured the use of their own self-constructed Goal State checks as means of validating manipulation accounting for 41.9% of manipulation check effects. Only 23% of effect

[7] References marked with an asterisk in the end of thesis reference list indicate studies included in this meta-analysis.

sizes were extracted from studies which included manipulation prompting, and only 27.4% in which experimenters were blind to conditions.

Manipulation was most commonly positioned prior to any task engagement (59.4 %) and getting participants to read manipulation instructions themselves was also most evident amongst effects coded (52.8%). In considering manipulation check effects only, positioning checks post-task was the most evident amongst studies from which effect sizes had been coded (58.1%). Although control group type was not specifically analysed, the provision of standard task instructions only (95.2%) as a control group type dominated the sample. Likewise, although the type of manipulation prompting used was not specifically analysed, providing manipulation reminders prior to start of experimental blocks was the most popular method (82%).

Composite Effect Sizes

An alpha level of .05 was used for all statistical tests. See table 2.2 for weighted mean effect sizes and associated statistics per subgroup. For manipulation check effect sizes, the subgroup of MAP and PAP comparisons produced a mean effect size of d = .56, z = 16.52, p < .001, and the subgroup of SGO and Control comparisons produced a mean effect size of d = .75, z = 10.91, p < .001. This

Table 2.2. Mean Effect Sizes by Subgroup

Subgroup	*K*	*Mean d*	*95% Lower*	*95% Upper*	*z*	*P*	***Q***	***p***
Manipulation Check Effects:								
MAP and PAP	31	.56	.50	.63	16.52	< *.001*	**205.02**	**< .001**
SGO and Control	12	.75	.62	.89	10.91	< *.001*	**77.99**	**< .001**
Task Performance Effects*:*								
MAP and PAP	36	.20	.13	.26	6.07	< *.001*	**94.43**	**< .001**
SGO and Control	27	.24	.15	.32	5.52	< *.001*	**24.86**	**.53**

indicates that manipulation checks appear to be successfully detecting differences between experimentally defined groups, as represented by medium to large effect sizes (Cohen, 1988) on manipulation checks. For task performance effect sizes, the subgroup of MAP and PAP comparisons achieved a mean effect size of $d = .20$, $z = 6.08$, $p < .001$, and for SGO and Control comparisons, $d = .24$, $z = 5.52$, $p < .001$. This indicates that experimental manipulations of MAP and PAP impacts upon task performance, although the size of this effect is small (Cohen, 1988).

Homogeneity analyses on manipulation check effect sizes, revealed that there was significant variation in effect sizes for subgroup MAP and PAP, $\chi^2(30) = 205.027$, $p < .001$, and for subgroup SGO and Control, $\chi^2(11) = 77.991$, $p < .001$, indicating there to be scope for investigation of moderating variables. Homogeneity analyses on task performance effect sizes also revealed there to be significant variation in effect sizes for subgroup MAP and PAP, $\chi^2(35) = 94.430$, $p < .001$, however, for subgroup SGO and Control analyses revealed there to be no significant variation in effect sizes beyond which would be expected from subject-sampling error alone, $\chi^2(26) = 24.862$, $p = .53$. Thus, although there was clear indication of the presence of moderator variables influencing differences between MAP and PAP groups on task performance, there was no reason to suspect any systematic variation in task performance effect sizes for the SGO and Control subgroup.

Analytic Strategy

In order to address all hypotheses, following composite effect size analyses, fixed effects models (Hedges & Vevea, 1998) were applied in which effect size variance is partitioned on the assumption that variability in effect sizes is derived from identifiable differences between studies[8]. Specifically, in order to address hypothesis one, whether manipulation method influenced manipulation check and task performance effect sizes, and hypothesis two, whether manipulation check type influence manipulation check effect sizes, each of the four subgroups of effect sizes were divided into categories on the basis of the relevant coded moderator variable (manipulation method, manipulation check type). Between-category effect sizes were calculated and compared. Known as the analog to the ANOVA, this approach partitions the total homogeneity statistic Q into the portion explained by the categorical variable of interest (Q_B) and the residual pooled within groups portion (Qw). The Q_B is then the weighted sum-of-squares of the mean effect sizes for each group around the grand mean and Qw the weighted sum-of-squares of the individual effect sizes within each group around their respective group mean, pooled over the groups (Lipsey & Wilson, 2001). That is, Q_B is an index of the variability between the group means and Q_W is an index of the variability within the groups. A significant Q_B indicates that the magnitude of the effects differs between the categories of the coded moderator variable, i.e., the grouping variable provided a significant contribution to the variance in the set of effect sizes. If Qw is not statistically significant, the coded moderator variable represented in Q_B is sufficient to account for the excess variability in the effect size distribution (Lipsey & Wilson, 2001). A significant Qw therefore indicates a heterogeneous distribution, i.e. the variability of the effect sizes was larger than would be expected from sampling error alone. A significant Q_W is therefore importantly informing us here that the coded moderator variable is not adequate enough in explaining the excess variability among effect sizes.

[8] Given that the composite effect size analysis for the subgroup of SGO and Control for task performance effect sizes was not significant as previously described, no analyses of heterogeneous distributions were conducted for this subgroup.

In order to assess hypothesis 3, that study characteristics will influence manipulation check and task performance effect sizes, weighted regression analyses were performed. Regression based analyses were deemed appropriate given that there were multiple study characteristic variables to be considered. A modified weighted least squares regression in which each effect sizes is weighted by the inverse of its variance was employed. A Q_R and a Q_E were calculated, reflecting a portioning of the total variability into the portion associated with the regression model (Q_R) and the variability unaccounted for by the model (Q_E). When Q_R is significant it is taken as an indication that at least one regression coefficient is significantly different from 0, but, when Q_E is significant then it is assumed that variability beyond subject-level sampling error still remains. Individual unstandardised regression coefficients (*B*-weights) were also examined to address the importance of each study characteristic variable. Study characteristic variables which were dichotomous (e.g., experimenter blindness) were entered into analyses as such, however, those categorical variables were dummy coded as sets of dichotomous variables, resulting in one variable less than the number of categories per moderating variable of interest (Cohen & Cohen, 1975). Specifically, MANIPULATION TIMING, MANIPULATION DELIVERY METHOD, and MANIPULATION CHECK TIMING, which all had three levels were each dummy coded into two new variables resulting in six new variables derived from these original three to be included in analyses[9,10]. Under such fixed effects models,

[9] Manipulation delivery method which consisted of the levels 1) via headphones 2) verbally by an experimenter 3) read by participant, were dummy coded into two new variables of READ (which compared the read by participant level to the others) and VERBAL (which compared the verbally by an experimenter level to the others). Manipulation timing consisted of the levels 1) prior to task involvement 2) following a training/practice phase 3) multiple points, were dummy coded into two new variables of PRIOR (which compared prior to task involvement level with the others) and POST_PRAC (which compared following a training/practice phase level with the others). Finally, manipulation check timing consisted of the levels 1) immediately following manipulation 2) post task 3) following a training/practice phase but still prior to main task engagement, which were dummy coded into two new variables of IMMEDIATELY (which compared immediately following manipulation to the other 2 levels) and POST_TASK (which compared post task to the other 2 levels).

when Q_W from the analog to the ANOVA, and Q_E from weighted regression analyses remained significant (in addition to a significant Q_B and Q_R) then it was assumed that the distribution of effect sizes being analysed remained heterogeneous even after modelling for between-study differences. When this was the case, a mixed effects model was applied, which assumes that the effects of the between-study differences are systematic but there is an additional remaining random component. Fitting such mixed effect models involves recalculation of the inverse variance weights based upon an estimation of a random effects variance component (V_0) which is achieved using the residual Q rather than total Q (Overton, 1998) and analyses are rerun with these new weights.

It is important to note at this point that when examining manipulation check effect sizes, if a manipulation check took place immediately after manipulation (prior to task engagement), and then within that study manipulation prompts were used throughout task engagement, it would be meaningless to analyse whether manipulation prompts contributed to manipulation check effect sizes. This is because prompting would have occurred after the time at which the measures where administered from which effect sizes were calculated. As such this variable was not included as a study characteristic in regression analyses for manipulation effect sizes. Rather than simply excluding this variable from interest in terms of its potential to influence manipulation check effect sizes, it was analysed separately using the analog to the ANOVA approach only for studies in which timing of manipulation check was post-task. Specifically, for the two manipulation check effect size subgroups, all effect sizes which came from a study in which a post task manipulation check had occurred

[10] It is important to mention the limits this action imposes on the interpretability of results. Current study sample sizes are smaller than those deemed acceptable for such an increase in the number of predictors (Miles & Shevlin, 2001).

were collectively divided into classes according to the variable of manipulation prompting and assessed using the analog to the ANOVA. In addition to this compatibility issue, it would also be meaningless to include the study characteristic of manipulation check timing in task performance based regressions. Apart from these, no other instances of such compatibility issues were identified.

The Influence of Manipulation Method

In addressing hypothesis one, effect sizes for each subgroup were partitioned into categories according to methods of manipulation employed, with the number of categories created within each subgroup representing the number of different manipulation methods present within that subgroup[11]. See table 2.3 for these fixed effects results.

Manipulation Check Effects: MAP and PAP

For manipulation check effect sizes, contrasts between manipulation method categories for the MAP and PAP subgroup under a fixed effects model revealed that a combined task purpose and goal frame method results in the largest manipulation effect (*d* =.80), whereas a provision of just a goal frame produced the smallest manipulation effect (*d* = .23). A manipulation method of task purpose and goal frame with the further addition of the provision of feedback as a combined method, also produced a medium manipulation effect (*d* = .62). Overall for this subgroup, manipulation method was found to significantly account for between category

[11] A fixed number of methodologies can't be stated here as methods varied across effect size subgroups. For example, although overall 9 methodologies were detected when coding data, for the MAP and PAP check subgroup a method of goal frame only was present, but, this method was not present within the SGO and Control manipulation check subgroup. Thus the total number of manipulation methods employed per subgroup varied.

Table 2.3. Moderator Analyses for Manipulation Method by Subgroup (Fixed Effects)

	K	*Mean d*	*95% Lower*	*95% Upper*	*z*	*P*	***Qw***	***P***
Manipulation Check Effects								
MAP and PAP								
Method 1	6	.23	.09	.37	3.18	*.002*	**10.63**	**.06**
Method 4	15	.80	.71	.90	16.09	*< .001*	**138.06**	**<.001**
Method 5	2	.30	.10	.50	2.98	*.003*	**.09**	**.76**
Method 6	2	.62	.33	.91	4.18	*<.001*	**.03**	**.86**
Method 7	6	.50	.32	.68	5.48	*<.001*	**3.67**	**.59**
		QB (4) = 52.51, *p* < .001						
		Qw (26) = 152.51, *p* < .001						
SGO and Control								
Method 4	4	1.27	.99	1.56	8.67	*< .001*	**38.50**	**< .001**
Method 7	3	1.14	.85	1.44	7.70	*< .001*	**3.87**	**.14**
Method 8	5	.40	.22	.58	4.33	*< .001*	**1.32**	**.86**
		QB (2) = 34.30, *p* < .001						
		Qw (9) = 43.69, *p* < .001						
Task Performance Effects:								
MAP and PAP								
Method 1	8	.19	.04	.35	2.43	*.02*	**4.64**	**.70**
Method 2	2	.11	-.07	.29	1.22	*.22*	**.13**	**.72**
Method 3	2	.00	-.37	.37	.00	*1.0*	**.00**	**1.0**
Method 4	12	.34	.22	.46	5.79	*< .001*	**73.71**	**< .001**
Method 5	7	.08	-.04	.21	1.28	*.20*	**2.83**	**.83**
Method 7	3	.26	.03	.49	2.20	*.03*	**1.74**	**.42**
Method 9	2	.13	-.13	.40	.99	*.32*	**.004**	**.94**
		QB (6) = 11.38, *p*= .07						
		Qw (29) = 83.05, *p* < .001						
SGO and Control								
Method 1	10	.38	.21	.55	4.43	*< .001*	**7.12**	**.62**
Method 2	4	.05	-.13	.24	.56	*.58*	**4.60**	**.20**
Method 4	4	.27	.05	.49	2.45	*.01*	**2.80**	**.42**
Method 7	2	.29	-.01	.58	1.91	*.06*	**2.34**	**.12**
Method 8	3	.20	-.01	.46	1.45	*.15*	**.50**	**.78**
Method 9	4	.22	.04	.40	2.37	*.02*	**.74**	**.86**
		QB (5) = 6.75, *p*= .24						
		Qw (21) = 18.11, *p* = .64						

Note. Methods: 1 Goal frame; 2 Feedback frame; 3 Task purpose; 4 Task purpose and goal frame; 5 Perception of ability; 6 Task purpose and goal frame and feedback frame; 7 Task purpose and feedback frame; 8 Task purpose and perception of ability; 9 Goal frame and feedback.

variability in effect sizes, $\chi^2(4) = 52.51$, $p < .001$, however within category variability was also found to be significant $\chi^2(26) = 152.51$, $p < .001$. This suggests that although significant variability is explained by the between group category variable (i.e., the mean effect sizes across categories differ by more than sampling error), the pooled within groups variance is heterogeneous. The between group category is therefore not adequate enough in explaining excess variability among effect sizes. Thus analyses were rerun using a mixed effects model (see table 2.4 for results) under which a between category effect was no longer significant meaning that manipulation method could no longer account for effect size variability.

Table 2.4. Moderator Analyses for Manipulation Method by Subgroup (Mixed Effects)

	k	*Mean d*	*95% Lower*	*95% Upper*	*z*	*p*	Q_w	***P***
Manipulation Check Effects								
MAP and PAP								
Method 1	6	.28	-.09	.65	1.46	*.14*	**1.59**	**.90**
Method 4	15	.81	.56	1.06	6.39	*< .001*	**44.87**	**< .001**
Method 5	2	.30	-.32	.93	.95	*.34*	**.01**	**.92**
Method 6	2	.62	-.04	1.28	1.83	*.07*	**.01**	**.94**
Method 7	6	.50	.09	.88	2.39	*.02*	**1.25**	**.94**
Q_B (4) = 6.78, p = .15 Q_W (26) = 47.73, p = .01								
SGO and Control								
Method 4	4	1.46	.91	2.01	5.18	*< .001*	**12.08**	**.02**
Method 7	3	1.09	.47	1.71	3.44	*.001*	**1.03**	**.60**
Method 8	5	.41	-.05	.87	1.74	*.08*	**.31**	**.10**
Q_B (2) = 8.70, p = .01 Q_W (9) = 13.42, p = .14								

Note. Methods: 1 Goal frame; 2 Feedback frame; 3 Task purpose; 4 Task purpose and goal frame; 5 Perception of ability; 6 Task purpose and goal frame and feedback frame; 7 Task purpose and feedback frame; 8 Task purpose and perception of ability; 9 Goal frame and feedback.

Manipulation Check Effects: SGO and Control

Fixed effects analyses for subgroup SGO and Control also revealed that the manipulation method to promote the largest effect was a combined task purpose and goal frame method (d = 1.27), with a combined method of task purpose and feedback following closely behind (d = 1.14). Manipulation method was found to significantly account for between category variability, $\chi^2(2) = 34.30$, $p < .001$, but that this variable couldn't fully explain excess variability as the within category analysis was also significant, $\chi^2(9) = 43.69$, $p < .001$. A mixed effects analysis was run (see table 2.4 for results) which further confirmed, albeit weaker, the significant influence of manipulation method in accounting for between category variability, $\chi^2(2) = 8.70$, $p = .012$, and under this mixed effects model, within category variability was not significant, $\chi^2(9) = 13.42$, $p = .144$, suggesting that variability beyond subject-level sampling error could be accounted partly by manipulation method and partly from random sources. Thus it seems that although the method used to manipulate experimental conditions could account for some variation in the effectiveness of manipulation here, there was still some additional unexplained variance. Specifically, it seems that the combined manipulation method of Task Purpose and Goal Frame was the key method accounting for variation in manipulation effetiveness.

Task Performance Effects: MAP and PAP

This subgroup presented the most variety in terms of the number of different manipulation methods used. Again, task purpose combined with goal frame methodology produced the largest manipulation effect (d = .34), although actually a small effect size (Cohen, 1988), with task purpose combined with feedback (*d* = .26) and a single goal frame (*d* = .19) producing slightly weaker effects. Interestingly, manipulations which focused on manipulating perceptions of ability (*d* = .08) and the provision of just a task purpose (*d* = 0), were found to present little to no effect at all. Fixed effects results provided some indication of an influence of manipulation method on task performance effect sizes for this subgroup, $\chi^2(6) = 11.38$, $p = .07$. Given that this result was not significant at the .05 alpha level caution was taken in interpreting within category analyses under this fixed effects model. These results essentially mirror those found for the equivalent manipulation check effects MAP and PA subgroup, albeit weaker.

Task Performance Effects: SGO and Control

As previously noted, analyses on this subgroup failed to reject the null hypothesis of homogeneity. However, with the aim of identifying whether there were any particular manipulation methods for this subgroup which generally represented small or large effects, exploratory analyses were run. Consistent with other subgroups, a combined task purpose with goal frame, and a task purpose teamed with feedback produced reasonable manipulation effects (*both d's* = .30). However, a single goal frame manipulation method produced the largest effect (*d* = .40).

The Influence of Manipulation Check Type

In addressing hypothesis two, effect sizes in the manipulation check subgroups were partitioned into categories according to type of check employed, with the number of categories created within each subgroup representing the number of different checks present within that subgroup. See table 2.5 for these results.

MAP and PAP

The use of an authors' own Goal State questionnaire as a manipulation check resulted in the largest of effects (d = .68). The other three types of checks present in this subgroup can, according to Cohen (1988), also be considered to have produced medium effect sizes as presented in table 2.5. Type of manipulation check employed was found to account for significant between category variability, $\chi^2(3) = 13.00$, p = .005, but there was still evidence of unexplained variability as represented by significant within category results, $\chi^2(27) = 192.03$, $p < .001$. A mixed effects model was thus run (see table 2.6), however between category effects became non-significant, $\chi^2(3) = 1.15$, p = .76.

SGO and Control

For this subgroup, the use of a Goal Recall check (d = 1.25), and a standard Goal State questionnaire check (d = 1.20), were both found to produce large effects. However for this subgroup an authors own Goal State questionnaire produced a slightly smaller effect (d = .40) than it did for the MAP and PAP subgroup. Manipulation check type categories were found to significantly account for effect size variability, $\chi^2(2) = 34.00$, $p < .001$, however within category variability was also significant, $\chi^2(9) = 43.99$, $p < .001$. As such, mixed effects analyses were run (see table 2.6) further supporting the between category effect of manipulation check type, $\chi^2(2) = 7.84$, p = .02, and the within category effect became non-significant, $\chi^2(9)$ = 14.03, p = .12, indicating that manipulation check type was sufficent to account for the excess variability in the effect size distribution.

Table 2.5. Moderator Analyses for Manipulation Check by Subgroup (Fixed Effects)

	K	*Mean d*	*95% Lower*	*95% Upper*	*z*	*p*	Q_w	*P*
MAP and PAP								
Check Type 1	4	.52	.33	.71	5.29	< .001	**.95**	**.81**
Check Type 2	13	.68	.59	.77	14.28	< .001	**71.03**	**< .001**
Check Type 3	11	.41	.28	.54	6.16	< .001	**119.79**	**< .001**
Check Type 4	3	.43	.22	.64	4.02	< .001	**.25**	**.88**
Q_B (3) = 13.00, p = .004								
Qw (27) = 192.03, p < .001								
SGO and Control								
Check Type 1	2	1.25	.93	1.57	7.62	<.001	**1.57**	**.21**
Check Type 2	5	.40	.22	.58	4.33	< .001	**1.32**	**.86**
Check Type 3	5	1.18	.92	1.45	8.72	< .001	**41.09**	**< .001**
Q_B (2) = 34.00, p <.001								
Qw (9) = 43.99, p < .001								

Note. Check Type: 1 Goal Recall check; 2 Authors own Goal State check; 3 Standard Goal State check; 4 Self-reported skill activity.

The Influence of Study Characteristics

In addressing hypothesis three, weighted regression analyses were run as previously described. However, separate analyses for each of the four subgroups were deemed inappropriate as, in particular, both SGO and Control subgroups didn’t have large enough sample sizes (*n* of effect sizes) to sensibly run regression analyses using the set of study characteristics of interest. Thus, to allow for an appropriate analysis of study characteristics the two subgroups (MAP and PAP, and SGO and Control) for manipulation check effect sizes and for task performance data were combined creating only two subgroups for analysis; on overall manipulation check subgroup and a task performance subgroup. Construction of these groups didn’t violate assumptions of independence beyond that already discussed in this chapter. Furthermore, homogeneity analyses on these two subgroups, revealed that there was significant variation in manipulation check, $\chi^2(42) = 289.08$, $p < .001$, and task performance,

Table 2.6. Moderator Analyses for Manipulation Check by Subgroup (Mixed Effects)

	K	*Mean d*	*95% Lower*	*95% Upper*	*z*	*p*	**Q_W**	***P***
MAP and PAP								
Check Type 1	4	.52	.01	1.02	2.01	*.04*	**.14**	**.99**
Check Type 2	13	.55	.27	.84	3.86	< .001	**6.87**	**.87**
Check Type 3	11	.73	.41	1.05	4.43	*< .001*	**39.56**	**< .001**
Check Type 4	3	.43	-.15	1.01	1.45	*.15*	**.03**	**.98**
Q_B (3) = 1.15, p = .76								
Q_W (27) = 46.61, p = .01								
SGO and Control								
Check Type 1	2	1.26	.52	1.99	3.34	*.001*	**.30**	**.59**
Check Type 2	5	.41	-.05	.87	1.73	*.08*	**.31**	**.99**
Check Type 3	5	1.31	.81	1.81	5.13	*< .001*	**13.43**	**.01**
Q_B (2) = 7.84, p = *.02*								
Q_W (9) = 14.03, p = .21								

Note. Check Type: 1 Goal Recall check; 2 Authors own Goal State check; 3 Standard Goal State check; 4 Self-reported skill activity.

$\chi^2(62) = 119.89$, $p < .001$, effects sizes, providing support for the application of regression analyses as described.

However, one issue to arise from taking this action was that both of these newly created subgroups contained effect sizes containing comparisons which where conceptually different (a subgroup containing MAP and PAP, and SGO and Control comparisons). As such, it is important to be clear that interest in terms of the role of study characteristics within this results subsection is regardless of group membership, in that, one is more generally interested in whether these study characteristics have the potential to influence manipulation check and task performance effect sizes within the state achievement goal literature. See table 2.7 for results.

Manipulation Check Effects

As previously described, the study characteristic of manipulation prompting was not included in these analyses. Analyses revealed that study characteristics

Table 2.7. Moderator Analyses for Study Characteristics (Fixed Effects)

	B	*95% Lower*	*95% Upper*	*Z*	*p*
Manipulation Check Effects					
PRIOR	.28	-.08	.64	1.51	*.13*
POST PRAC	.18	-.15	.52	1.07	.28
READ	.46	-.00	.91	1.95	.05
VERBAL	.19	-.24	.63	.87	*.38*
Experimenter Blindness	.69	.50	.89	7.06	*< .001*
IMMEDIATELY	-.13	-.36	.10	-1.13	*.26*
POST TASK	.54	.32	.76	4.76	< .001
			$R^2 = .28$		
			QR (7) = 81.90, $p < .001$		
			QE (35) = 207.18, $p < .001$		
Task Performance Effects					
PRIOR	-.11	-.53	.32	-.49	*.62*
POST PRAC	-.06	-.50	.38	-.26	*.79*
READ	-.09	-.36	.18	-.67	*.50*
VERBAL	-.17	-.42	.08	-1.33	*.18*
Manipulation Prompting	-.002	-.14	.14	-.04	*.97*
Experimenter Blindness	-.13	-.29	.04	-1.52	*.12*
			$R^2 = .08$		
			QR (6) = 9.52, $p = .15$		
			QE (56) = 110.36, $p < .001$		

significantly accounted for variance in effect sizes, $\chi^2(7) = 81.90$, $p < .001$. In particular, experimenter blindness ($\beta = .69$, $p < .001$), timing manipulation checks post-task ($\beta = .54$, $p < .001$), and getting participants to read manipulation instructions as a delivery method ($\beta = .46$, $p = .05$). However, analyses revealed there still to be unexplained variability, $\chi^2(35) = 207.18$, $p < .001$. Analyses were rerun under a mixed effects model (see table 2.8), under which, a model of study characteristics remained significant, $\chi^2(7) = 38.09$, $p < .001$, and residual analyses were no longer significant, $\chi^2(35) = 40.22$, $p = .25$, suggesting that the within subjects variance was homogeneous and thus that excess variability in effect sizes could be adequaltey explained by a model of study characteristics.

Table 2.8. Moderator Analyses for Study Characteristics (Mixed Effects)

	B	*95% Lower*	*95% Upper*	*Z*	*p*
Manipulation Check Effects					
PRIOR	.23	-.54	.99	.58	*.56*
POST PRAC	.13	-.60	.86	.35	.73
READ	.57	-.50	1.67	1.06	.29
VERBAL	.11	-.93	1.15	.21	*.83*
Experimenter Blindness	1.01	.62	1.40	5.05	< *.001*
IMMEDIATELY	-.26	-.80	.29	-.92	*.36*
POST TASK	.66	.18	1.14	2.69	.01
			$R^2 = .49$		
			QR (7) = 38.09, $p < .001$		
			QE (35) = 40.22, $p = .25$		

Task Performance Effects

As also previously described, the study characteristic of manipulation check timing was not included in these analyses. The model of study characteristics was unable to explain significant variation in effect sizes, $\chi^2(6) = 9.52$, $p = .15$. None of the study characteristics were found to be able to account for variation in task performance effect sizes.

The Influence of Manipulation Prompting on Post Task Check Effects

Homogeneity analyses on this post task based manipulation check subgroup provided initial support, $\chi^2(24) = 234.02$, $p < .001$, for the following analysis. Categorical analyses (see table 2.9), specifically examining effect sizes from studies in which a post task manipulation check was employed, regardless of which groups where being compared, revealed that when manipulation prompts were used, larger effect sizes were achieved ($d = 1.19$) relative to when no prompts are used ($d = .35$). Manipulation prompting significantly accounted for between category variability, $\chi^2(1) = 108.66$, $p < .001$, but could not account entirely for excess variability, $\chi^2(23) =$

Table 2.9. Moderator Analyses for Manipulation Prompting (Fixed Effects)

	K	*Mean d*	*95% Lower*	*95% Upper*	*z*	*P*	Q_w	***P***
Post Task Manipulation Checks								
Prompting	11	1.19	1.07	1.30	20.09	*<.001*	**115.02**	**< .001**
No Prompting	14	.35	.24	.45	6.31	< .001	**19.34**	**.11**

Q_B (1) = 108.66, p < .001
Qw (23) = 134.36, p < .001

134.36, p = < .001. Under a mixed effects model (see table 2.10), manipulation prompting remained a significant between category variable, $\chi^2(1)$ = 19.23, p < .001, and the within category effect was no longer significant, $\chi^2(23)$ = 27.83, p = .22. Thus it seems that manipulation prompting, in addition to contribution from random sources, can account for effects observed on post task manipulation checks.

Discussion

The primary objective of this meta-analytic investigation was to inform the design of the experimental work presented in chapters 3 to 6 of the current thesis. Overall, consistent with previous meta-analytic findings (Rawsthrone & Elliot, 1999; Utman, 1997) study design features were found to have an influence on observed effects. Specifically, there was some indication that manipulation methodology influences effects of goal state manipulation. A combined method of providing a task purpose and an assigned goal frame was most effective in producing observable differences between experimental groups. Additionally, the type of manipulation check used to assess the effectiveness of manipulation was found to influence the magnitude of effects. Study characteristics, such as experimenter blindness and the use of manipulation prompts, were also found to particularly account for variation in manipulation check effect sizes. These findings will now be discussed and

Table 2.10. Moderator Analyses for Manipulation Prompting (Mixed Effects)

	K	*Mean d*	*95% Lower*	*95% Upper*	*Z*	*P*	Q_w	***P***
Post Task Manipulation Checks								
Prompting	11	1.50	1.14	1.88	7.90	*<.001*	**25.89**	**.003**
No Prompting	14	.40	.07	.72	2.40	.02	**1.94**	**.99**

Q_B (1) = 19.23 , $p < .001$
Q_W (23) = 27.83, $p = .22$

implications drawn for the design of the experimental work to be conducted in this thesis.

Manipulation Method

Hypothesis one proposed that manipulation methodology would alter the magnitude of group differences observed on manipulation checks and task performance. There was no support that manipulation methodology could account for task performance effect size variation when considering either SGO and Control comparisons. That is, it seems that the method employed to manipulate experimental groups does not seem to have much of an impact on the extent to which we observe differences on an experimental task between an achievement goal state group and a control group.

In considering MAP and PAP comparisons, there was some, albeit weak, indication that the method of manipulation employed could explain differences in effect sizes. For manipulation check effect sizes, methodologies employed within this MAP and PAP subgroup were found only to account for variability under a fixed effects model. Also under a fixed effects model, for task performance effect sizes, methodology was only found to explain variation with a *p* value of .07. Thus, although one might be inclined to suggest that this variable should not be completely disregarded in terms of its potential to moderate group differences on task performance, it must be accepted that when considering affects on MAP and PAP comparisons there are other possible, more important, factors at play.

Manipulation methodology demonstrated its most significant influence on SGO and Control comparisons of manipulation check effects. A mixed effects model confirmed that method of manipulation could partly account for variation in the magnitude of manipulation check effect sizes, i.e., accounting for the extent to which one would be likely to conclude that a manipulation had been effective, in addition to the contribution of random sources. Findings therefore imply that manipulation methodology plays the most significant role when comparing either a mastery-approach or performance-approach goal state to a control condition. Arguably, this suggests when designing and interpreting research which examines an achievement goal state to a control, particular attention should be given to the way in which experimental conditions are manipulated.

Most importantly, despite the mixed overall model findings here, what was identifiably consistent across subgroups in examining the influence of manipulation method, was the particular impact of the method of provision of a task purpose in addition to the assignment of a goal frame (e.g., *the purpose of this task is to.….as such your goal is to achieve/focus on…..*). This combined method was not only generally found to present the largest manipulation and task performance effects relative to other methods, but that for manipulation checks in particular these were actually quite large effects (Cohen, 1988). Manipulation checks therefore seem to be able to identify group differences more successfully when this specific method of manipulation is used. As such, this method can be identified as the most effective way of successfully inducing achievement goal states.

The two other methods which also demonstrated reasonable mean effect sizes in comparison to other methods, was a combined method of the provision of a task purpose and task feedback, and a combined method of task purpose, a goal frame and feedback. There is clearly some consistency here, in that partial or complete multidimensional combinations of a task purpose, goal frame and feedback are very effective methods of manipulation and for producing task performance effects.

Those manipulation methods which included, either in isolation or in combination with another approach, a reference to perceptions of ability, i.e., methods which attempt to manipulate achievement goal states through manipulating perceptions of ability (e.g., creating the perception that ability is stable and difficult to improve and thus that the better ones task performance the higher ones ability in comparison to others; performance-approach) seemed to produce little to no effect. This is somewhat fitting with goal state and working memory studies in particular which have used such methodology and found null manipulation effects (Linnenbrink et al., 1999). This was especially evident for the task performance MAP and PAP subgroup for which when this method was used, no effect was found. Such findings imply that this methodology is not an effective one for successfully observing differences between a mastery-approach and performance-approach goal state on task performance.

Manipulation Check Type

Overall, analyses revealed that the type of check used to confirm manipulation effectiveness, did have the potential to influence manipulation check effect sizes. For the subgroup of MAP and PAP, a fixed effects model suggested that type of check used could account for variability between check type categories, but that this variable could not fully account for effect size variability. The use of an author's own Goal

State check produced the largest effect. This is interesting, as the actual content of the measures will obviously vary considerably, given that they are composed of ‘one-off’ items created by authors specifically for their own study. Clearly it would be absurd to suggest on the basis of such findings that researchers should focus on producing their own manipulation check scales to assess Goal State with the aim of increasing the likelihood of detecting manipulation effectiveness. Rather, caution may be warranted when interpreting manipulation effectiveness within studies that have relied upon an author's own measure, as clearly this has a tendency to inflate effect sizes when comparing MAP and PAP manipulation effectiveness. It is difficult to unambiguously determine the reason for this. One possible explanation might be that authors tend to closely match manipulation check items with the terminology or framing of the actual manipulation, making it easier for participants to relate to their manipulated state based experiences when completing such checks. More controversially, these results could be parsimoniously explained by post-hoc selection of items that maximise observed effects on manipulation checks.

The use of a standard Goal State check measure was found to produce a small to medium effect in identifying differences between a manipulated MAP and PAP state. Thus, although this type of check didn’t produce as large as an effect as an authors own check measure, it still seems to be able to successfully identify differences in the experience of either a mastery-approach state or performance-approach state. Additionally, the use of a Goal Recall check type in which participants are asked to confirm their assigned condition, also produced a medium effect size when comparing MAP and PAP conditions. This suggests that the employment of such a check is quite important, and effective, in confirming whether participants actually understood and were attentive to, their assigned achievement goal state.

For the SGO and Control subgroup, check type used was found to be able to partially account for manipulation check effect sizes under a mixed effects model. The use of a Goal Recall check and employment of a standard Goal State check measure, were both found to result in large effect sizes. Interestingly, for this subgroup the use of an authors own Goal State check didn't produce as large as an effect for the MAP and PAP subgroup, but did still produce a small effect. This implies that author constructed items are more effective at detecting differences between two state achievement goal groups relative to differences between a state achievement group and a control. Additionally, the fact that the use of Goal Recall checks resulted in larger effects for SGO and Control comparisons, relative to MAP and PAP comparisons, arguably represents the ease with which such a check can differentiate between recall of the assignment of an achievement goal versus no achievement goal, comparative to differentiating between two achievement goal states.

Obviously a Goal Recall check is different from a Goal State check, as it is more concerned with informing a researcher as to whether a participant is able to recall under what state they were asked to perform. It is therefore inappropriate to pit a Goal State check against a Goal Recall one in order to reach a conclusion as to which is more effective or useful. Alternatively, it seems from the current findings, that both offer much potential in assessing manipulation effectiveness, i.e., confirming overall that these manipulation checks seem to be working.

Study Characteristics

Investigation of the role of study characteristics on manipulation check effect sizes, regardless of group comparison, revealed that such characteristics could significantly account for effect size variability in addition to contributions from random sources under a mixed effects model. Specifically, a model which addressed the timing of manipulation, delivery method of manipulation, experimenter blindness and timing of a manipulation check type, could partially explain variability in the magnitude of manipulation check effect sizes. The most important study characteristics identified to be able to explain such variability, were if participants were asked to read manipulation instructions themselves as a manipulation delivery method, if an experimenter was blind to conditions, and if a manipulation check was taken post-task. All three of these characteristics in particular seemed to facilitate the detection of differences between groups on manipulation checks. Interestingly, the timing of manipulation, i.e., prior to any task engagement or following practice or training phases, seemed to be unable to explain any variability in manipulation check effect sizes.

For the role of delivery method in particular, it is quite possible that if a participant is required to read instructions regarding manipulation independently, there is more of a chance that the information will be digested (e.g., re-reading, regulating the pace of reading, self-elaboration). Thus, arguably more of a chance that the desired state will be manipulated, or at least understood. Also, there is a possible argument here that the mere fact that an experimenter either on a pre-recorded tape or actively in the participant's presence, delivers manipulation information could possibly confound group effects. This could be by ‘damaging’ a mastery-approach state in particular whereby the presence or judgment of others could be considered to manipulate more performance-approach based thoughts. Or, consistent with the social facilitation literature (e.g., Geen, 1989), that the general presence of an experimenter (or their voice) increases experienced anxiety or pressure on the participant's behalf when the instructions are actually being read, in turn reducing attention to or engagement with the manipulation.

The role of experimenter blindness also raises some imperative issues. Findings suggest that when an experimenter is blind to conditions we are more likely to find larger manipulation check effects. It is possible that when an experimenter is not blind to condition they are more likely to react or behave in a way which manipulates or adapts manipulations slightly between participants, e.g., an experimenter aware of conditions might be more likely to restate manipulation information or provide personal 'add ons' to standardised manipulation information if they think a participant has not fully engaged with or understood a manipulation. This is turn might foster inconsistency between participants within the same condition for example, making it less likely that manipulation checks will pick up on between condition effects. In other words, when an experimenter is blind to conditions, a testing session is perhaps more likely to run with strict adherence to a standardised procedure, resulting in more within condition consistency and thus more identifiable between condition effects.

Finally, it seems that when a manipulation check is taken post task one is more likely to detect significant differences between experimental conditions. That is, conducting a post-task manipulation check which specifically addressed whether a participant did actually experience a manipulated state when performing (i.e., *during the task I did…*), relative to when a manipulation check is taken immediately following manipulation or once a training or practice phase has been completed after manipulation but both prior to actual task engagement (i.e., *in the forthcoming task my aim is to….*) which both represent intention to perform under a manipulated state, is more effective at detecting differences between experimental groups. It seems reasonable to suggest that when a manipulation check is taken post-task it is an effective and superior reflection (indication) on whether the manipulation did actually work, i.e., whether a participant actually experienced being in a desired state when performing a task, rather than their intention to perform under a desired state, which arguably could diminish once engaged with a task missed by a pre-task manipulation check which makes attributing differential task performance effects to experimental groups problematic. Additionally, separate analyses revealed that for studies in which a post-task manipulation check was specifically used, the inclusion of manipulation prompting (i.e., repeating or reminding participants of the manipulation during task performance) produced larger manipulation effects. This finding suggests that prompting is an effective tool for maintaining and keeping participants updated on the desired focus on their assigned condition. Prompting seems to serve as an effective way of preventing distraction from, or even disregard of, ones assigned focus, increasing the likelihood that post-task manipulation checks will detect that participants did in fact experience the desired manipulated state.

The findings from the current investigation however, found that a study characteristics model of timing of manipulation, manipulation delivery method, manipulation prompting and experimenter blindness could not explain any significant variance in task performance effect sizes. None of these study characteristics were found to contribute to variability in such effect sizes. Thus it seems that study design features hold more important implications when validating manipulations, rather than when considering the extent to which such manipulated groups perform differently on experimental tasks.

Limitations

The current meta-analytic investigation has succeeded in identifying important design aspects which contribute to the magnitude of effect sizes when examining manipulation effectiveness and task performance differences within the state achievement goal literature. One has to accept however that given that only published studies were included in the current investigation, there is a risk of overestimating the effectiveness of manipulations and potential of manipulations to produce observable task performance differences. Additionally, the number of effect sizes in each subgroup could be considered to be on the small size in accordance with the recommendations of Hunter and Schmidt (1990b, 1994). These points combined suggest that current findings should be interpreted with caution and rather seen as an initial indication of the potential of manipulation methodology, manipulation check type and other study characteristics to influence effect sizes observed within a very specific subset of the state achievement goal literature. Additionally, it is worthy to note here that given the investigations focus specifically on informing the work of the current thesis it is a highly selective examination and should be interpreted as such.

Although inclusion criteria was set very specifically and carefully in line with the aims of the current investigation, it arguably still resulted in the exclusion of studies which could have provided much value, or shared potential overlap with the theme of the experimental work presented in the current thesis. Thus, particular manipulation methods or manipulation check types which could hold value for the design of the experimental work in the current thesis, may have actually been excluded. For example, a reasonable amount of research which has examined the relations between achievement goals and cognition has employed a child sample (e.g., Graham & Golan, 1991). However, given that the findings of the current meta-analytic examination were required to specifically inform on manipulations on healthy adults, effect sizes from studies which employed child samples were excluded. Thus although this satisfied the need to ensure that, for example, effective methods of manipulation were effective for healthy adults specifically, it came at the cost of losing potentially valuable information regarding cognitive performance under a particular manipulation method.

Concern regarding inclusion criteria is also evident when considering study characteristic variables that had to be dropped from analyses. In that, although as discussed early in this chapter, there is variability in assignment to conditions, kind of manipulation prompts used and in the response scales used to assess manipulation effectiveness, the final subgroups for the present investigation didn’t provided enough effect sizes representing variability on these factors to allow for investigation. An important example here, which holds implications for the design of the experimental work of the current thesis, is the nature of control groups when compared to a manipulated state achievement goal condition. Although it was initially hoped that the type of control condition could be investigated in terms of what kind of control group (e.g., do your best, or, standard task instructions only) is more likely to produce observable group differences with a state achievement goal condition, unfortunately the final sets of effect sizes which included control group comparisons were so heavily biased on the provision of standard task instructions only, relative to other control condition approaches, that this could not be sensibly analysed as a study characteristic. Clearly it would be difficult to attempt to satisfy all possible needs here as one would have to then resort to combining effect sizes with variability beyond the scope, or more importantly beyond the purpose, of the present meta-analytic investigation. Furthermore, there really wasn’t enough research, providing enough effect sizes, to sensibly open up investigation to such a level as the number of effect sizes per category of a moderator variable would become very limited, and the number of analyses needed to be run would be excessive.

Another particular limitation that stems from the previous point, concerns the extent to which within some of the categories created by coding for manipulation check type in particular, there were combination of effect sizes which actually still presented a lack of consistency. For example, when creating the category of standard Goal State checks, one combined effects from studies that used different types of standard measures from the literature (e.g., both the, Patterns of Adaptive Learning Survey [PALS], Midgley et al., 1996; and the, Achievement Goal Questionnaire, Elliot & McGregor, 2001). Similarly, and as previously noted in this discussion, when creating the category of authors' own Goal State check, effect sizes were combined from studies in which such checks varied quite substantially still, for example, in terms of the quality, number and framing of items, and in how participants were required to response to such items. Given the limited number of effect sizes and important need to adhere to the inclusion criteria of the current investigation, these were necessary combinations, but, it is likely that checks within each of these check type categories differ in terms of sensitivity to, or ability to capture, either an achievement goal state or control condition. Although arguably much has been gained from investigation of these categories, it must be noted that when the literature becomes more fruitful then further meta-analytic investigation which could decompose such categories more precisely would be beneficial.

A final limitation necessary to draw attention to is the issues surrounding the homogeneity analyses for the task performance subgroup of SGO and Control comparisons. Such initial analyses indicated little support for the presence of moderator variables when comparing these groups on task performance. Of course, it could actually be the case that manipulation aspects and study characteristics play little of a role here. However, one must be attentive to the fact that combining both mastery-approach and performance-approach, to create an overall SGO group could have contributed to these null effects. Within the literature, there has been some variability in terms of whether a mastery-approach or performance-approach state condition perform more closely to a control. In other words, some researchers have found state performance-approach to more perform more consistent with a control, relative to state mastery-approach, whereas, others have found the opposite (see experiment 1 & 2, Van Yperen et al., 2009, for such variation). Combination of these may have suppressed effect size variability. Although, as described in the method section of this chapter, that such combination was essential due to lack of effect size entries and need for meaningful analyses, one should interpret the found homogenous distribution of SGO and control task performance effects with care. Again, as this literature develops it would be very beneficial to direct meta-analytic investigation specifically to both MAP and control, and PAP and control, comparisons as this would provide much information too on whether particular manipulation methods or manipulation checks compromise or facilitate effects for a particular goal state in comparison to a control.

Implications For The Current Thesis

The findings of the current meta-analytic investigation encourage the following recommendations for the design of the experimental work to be presented in chapters 3 to 6:

- A multidimensional manipulation method involving the combination of an assigned task purpose with an associated goal frame will be employed to manipulate achievement goal states.
- Although no analyses were specifically run to address what kind of control condition is most suited to observe group differences, given the popularity and thus presence of the provision of standard task instructions only, this is the approach that will be adopted. At the very least, this will ensure that the application of findings from the current meta-analytic investigation are kept consistent and thus relevant with the type of control conditions used in studies upon which effect sizes have been extracted.
- Despite the large effect achieved when the use of an authors own Goal State manipulation check is employed, it will not be adopted. Firstly, it makes no sense to suggest that any measure an author devises will be advantageous to a standard state measure. Secondly, the use of such ad-hoc measures really prevents findings from being easily compared across studies. Finally, as previously described, an author's own measure opens the door to potential bias. Thus, alternatively based on the content of the manipulation check type discussion section within the current thesis, both a Goal Recall and a standard Goal State check will be employed. Although analyses don't offer any advice on which specific standard Goal State check measures should be used, one will be selected from the studies from which effect sizes were extracted in the current investigation.
- Participants will be required to independently read manipulation instructions. That is, assignment of a task purpose and goal frame (i.e., the

intended method of manipulation) will be delivered via standardised written instructions that participants will read.

- Although experimenter blindness has been found to be an important factor in detecting group differences, given that all of the research presented in the current thesis is being independently conducted by one primary researcher (Rachel Avery) there would be some difficulty in remaining completely blind to condition. This is important given that, as will be described in later chapters, assignment to conditions will be coordinated to ensure equal levels of certain ability variables by the primary researcher. Thus, although complete blindness to conditions could not be achieved in the forthcoming experimental work, strict adherence to standardised experimental procedures will be upheld as specifically described in each of the method sections within chapters 3 to 6.
- Manipulation checks, both Goal Recall and standard Goal State checks, will be taken post-task as means of assessing whether a participant can correctly recall what their assigned condition was, and whether the desired manipulated state was actually experienced by that participant during task performance.
- Manipulation prompting will be employed. Although specific details of the kind and style of prompting was not analysed in the current meta-analytic investigation, again, the most popular and evident approach used in the studies employing a combined task purpose and goal frame (given that this is the intended manipulation method) from which effect sizes were extracted will be employed, specifically, a reminder of one's goal frame at the start of task round/block.

CHAPTER 3

Study 2[12]

[12] The study presented in this chapter has been accepted for publication by *Motivation and Emotion*: Avery, R. E., & Smillie, L. D. (in press). The Impact of Achievement Goal States on Working Memory. *Motivation and Emotion*.

Overview of Chapter

The purpose of this chapter is to conduct a preliminary investigation of whether the experimentally manipulated achievement goal states of mastery-approach and performance-approach differentially influence working memory processing. It aims to do so whilst addressing and overcoming some of the key limitations identifiable in previous research within this area. Additionally, such investigation provides the opportunity for the meta-analytic findings presented in the previous chapter to be tested specifically within an achievement goal-working memory context. Firstly, limitations of previous research addressing the achievement goal-working memory relationship, touched upon in the introductory chapter of this thesis, will be reviewed more thoroughly. Then, given the interpretative difficulties of existing research, specific directional predictions will not be presented, but, it will be predicted that the influence of achievement goal states on working memory processing will diverge for mastery-approach and performance-approach conditions. Finally, research findings are presented and discussed specifically in line with the implications for the design of the experimental work presented in chapter four.

Background Review

As already noted in chapter 1, very little research has explicitly addressed the relation of the experimentally manipulated achievement goal states of mastery-approach and performance-approach to working memory or related processes. Many of the studies that have done so suffer from problems relating to experimental and statistical control. For instance, the use of control groups and manipulation checks is sporadic at best, thus the true extent to which comparisons between experimental conditions or groups genuinely reflect the specific achievement goal states of interest is often not known. Researchers have sometimes found significant working memory performance differences between a control group and one or another achievement goal group, but no difference between the achievement goal groups of mastery-approach and performance-approach (e.g., Parkes et al., 1998). Some researchers have pointed out that the nature and interpretive meaning of a control condition is often not clear, given that all individuals are presumed to adopt an achievement goal of some kind during an achievement task (Murayama & Elliot, 2011). Despite this, one can argue that inclusion of a control offers more potential to inform ones understanding of the achievement goal-working memory relationship.

The infrequent use of manipulation checks is particularly concerning. As noted in chapter 2, lack of manipulation checks is a problem because manipulation effectiveness becomes highly questionable. Furthermore, variation in the kind of manipulation checks used is problematic as these differ substantially in terms of their likelihood of yielding a significant result. It is particularly concerning that author own derived manipulation check items, according to chapter 2 findings, are the most successful in some instances. A lack of manipulation checks also highlights the possibility of overlooked discrepancy between whether one achievement goal state was more successfully induced over the other, which in turn could clearly impact upon differential working memory performance. For example, Barker et al. (2002) neglected to assess the effectiveness of their goal manipulations and found no superior working memory related processing effects for a mastery-approach condition (contrary to previous findings relating to immediate and free recall), but did find performance effects for a performance-approach condition. Of course, this could mean that the mastery-approach manipulation was successful but did not exert any performance effect. However, it is also possible that only the performance-approach manipulation, and not the mastery-approach manipulation, had been effective. Failure to include manipulation checks is therefore a major source of uncertainty in the interpretation of existing findings. Furthermore it is also apparent that much of the research within this area that has included manipulation checks has not employed the methods identified to be the most effective in the previous chapter 2.

Furthermore, research within this area has often failed to measure or control for non-focal variables that are strongly related to working memory. In particular, many researchers have neglected to eliminate the potential confound of cognitive ability. Meta-analytic reviews of the ability literature suggest that, although working memory is a distinct construct, it is highly related to reasoning ability and general intelligence (Ackerman, Beier, & Boyle, 2005; Kane, Hambrick, & Conway, 2005; Oberauer, Schulze, Wilhelm, & Süβ, 2005). This lack of control for cognitive ability is particularly disappointing given the recognition of the interactive effects between ability and motivational constructs. For example, Kanfer and Ackerman (1989) have shown that goal setting has differential effects depending on an individual's level of cognitive ability. Others have also found that (trait assessed) goal orientation and cognitive ability interact with actual performance, with mastery-approach being more generally adaptive for higher ability individuals. In addition, although performance-approach seems to play a relatively weak role for low ability individuals, high ability individuals seem to exhibit performance decrements when higher in performance-approach (Bell & Kozlowski, 2002). State performance-approach however has also been found to interact with ability, with such goal pursuit resulting in deterioration of appropriate task strategies when pursued by low ability individuals (Elliot & Dweck, 1988).

In line with research that has also demonstrated that individuals with high ability benefit from the use of complex strategies to maximise their performance, whereas low ability individuals have fewer resources to apply complex strategic approaches (Hunter & Hunter, 1984; Ree & Earles, 1991), it further seems imperative to account for ability when examining effects of achievement goals on working memory. For example, if a high ability individual who normally relies upon complex strategies is induced into a performance-approach state, which fosters reliance upon less complex strategies, they might perform differently from a low ability individual induced into this state who typically relies more on surface strategies. Although one would expect random group assignment to result in equivalent group means on ability, it is also true that by assessing relevant control variables one is able to more confidently rule out alternative explanations. This later point is of particular value given the previously discussed correlations between ability and working memory performance.

Interestingly, only two of the previously described achievement goal-working memory related studies, to the knowledge of the current thesis author, has attempted to account for cognitive ability. Parkes et al. (1998) who observed poorer Reading Span (RSPAN; Daneman & Carpenter, 1980) processing performance (as indicated by sensibility judgements of sentences, not capacity) for those assigned to a performance-approach condition relative to a no-goal control condition, found verbal ability (as measured by Nelson-Denny Reading Test) to be a significant covariate of this relation. Interestingly, DiCintio and Parkes (1997) who found that those assigned to a mastery-approach condition had superior RSPAN scores than those in a performance-approach condition, actually assigned participants to either one of these goal state conditions stratified based upon their verbal ability scores. Consequently, these authors were then able to confirm that there was no significant difference between experimental conditions based on these ability scores and therefore that span performance differences observed were unlikely to be confounded by cognitive ability.

Important conclusions follow from this: Firstly, ability variables used as controls in both of these studies are clearly selected to coincide with the type of working memory measure being investigated. Secondly, findings from these studies that have addressed ability encourage the view that achievement goal pursuit may influence working memory beyond cognitive ability. Despite this, however, given that such efforts to account for cognitive ability are sparse and entirely based on capacity indicators of working memory, the extent to which motivation-related performance differences between state groups goes beyond that of possible individual, and indeed group, differences in cognitive ability is still not fully understood.

A further limitation within this research area is that trait goal orientation is rarely accounted for when examining state effects. Given that much research has confirmed the distinction between these trait and state forms (Chen et al., 2000; Ward et al., 2004), with evidence of these variables each uniquely influencing participants responses (Kozlowski et al., 2001), it is surprising that this is the case. According to the Resource Allocation Theory (Kanfer & Ackerman, 1989), those high in trait mastery exposed to a state performance goal, or, those high in trait performance exposed to a state mastery goal, may struggle to balance the conflict between such orientations. Kanfer and Ackerman (1989) specifically propose here that these combinations are beneficial only when a task can be learned quickly, however, such a mixture may not be beneficial on more complex tasks. Moreover, research has confirmed that perceptions of the context and an induced state achievement goal can vary as a function of one's dominant trait goal orientation (Harackiewicz et al., 1998; Linnenbrinck & Pintrich, 2001). This stresses the importance of ensuring that trait goal orientation is accounted for when attending to differences in working memory performance for achievement goals, by ensuring that such trait equivalents don't significantly differ across state experimental groups.

Also omitted in the limited research in this area is accounting for the role that anxiety might play in the achievement goal-working memory relationship. It is possible that the effect of state achievement goal manipulations on affect may influence affective states beyond motivation. For example, it is possible that the specification of normative criteria for a performance-approach goal (triggering comparative thoughts in regards to others) may elevate anxiety (see Gibbons & Buunk, 1999) as implied by previous researchers who have attempted to address the achievement goal-working memory link (DiCintio & Parkes, 1997; Linnenbrink et al., 1999; Parkes et al., 1998). To account for this, state anxiety should be assessed. Such assessment should also be considered important on the basis of the known negative impact of anxiety on working memory performance (Ashcraft & Kirk, 2001; Ikeda, Iwanaga, & Seiwa, 1996; MacLeod & Donnellan, 1993).

A final critical problem within this research area to be noted here is that key achievement goal state-working memory studies described have been restricted entirely to set-based span tasks (e.g., reading span) typically used to assess individual differences (Conway et al., 2005). Research here has therefore been restricted to capacity indicators of working memory performance, rather than continuous processing or more complex working memory indicators. Employing such a latter paradigm would allow for pre-existing differences in working memory capacity, along with other relevant individual difference variables that are almost certain to influence working memory processing (e.g., cognitive ability) to be accounted for. Also, as initially discussed in chapter 1, task performance differences between a mastery-approach and performance-approach focus typically emerge under the more effortful cognitive conditions (Barker et al., 2002; Graham & Golan, 1991; Winters & Latham, 1996). Thus examining the influence of achievement goals on working memory processing across load would be particularly advantageous.

An ideal candidate paradigm for this purpose is the N-Back task (Gevins & Cutillo, 1993; Jonides, Schumacher, Smith, Lauber, Awh, Minoshima, & Koeppe, 1997). This requires participants to monitor a stream of stimuli and decide for each whether it was presented a given number of positions back in the sequence stream. As such, the task demands continuous monitoring, updating, storing and discarding of items in immediate memory, involving considerably more manipulation and a greater executive load than is typical with normal memory span tasks. Level of load can be varied from one-back, which simply involves detecting repetitions, up to three or even four-back, requiring the participant to hold and manipulate simultaneously four different items (Baddeley, 2007, p. 219). Research suggests that as N-Back load increases (i.e., as the previous stimuli to be matched to the present stimuli is positioned further back in the sequence stream), the greater the executive load involving more manipulation, rather than just maintenance, of stimuli within the working memory system (Baddeley, 2007; Kane, Conway, Miura, & Colflesh, 2007; Owen, McMillan, Laird, & Bullmore, 2005). Various verbal and non-verbal versions of the task have been developed including letter and number versions, and picture and spatial versions. The N-Back task is used extensively as a working memory paradigm. Research investigating this task’s reliability has concluded that this task is not a useful measure of individual differences in working memory, but is particuarly useful for experimentally loading working memory and examining processing, especially when examined at higher levels of load (Jaeggi, Buschkuehl, Perrig, & Meier, 2010). Furthermore, the task has also been used widely in neuroimaging studies. Bilarteral activation in frontal and parietal areas has been found using all versions of the task, consistent with the assumption the both central executive, visuospatial and phonological subsystems are involved, and that activation level increases linearly with load (Jonides et al., 1997; Owen et al., 2005).

Although (to the current thesis author's knowledge) no research has examined the impact of achievement goal states on N-Back performance, one study found that participants instructed to 'do well as your ability is being assessed' (denoted the 'high motivation' group), in comparison to 'this is a pilot task to optimise parameters' (denoted the 'low motivation' group), didn't differ in terms of task accuracy but had faster N-Back reaction times specifically in the higher, versus low, load conditions (Bengtsson, Hakwan, & Passingham, 2009). Also of interest is research suggesting that spatial N-Back performance is enhanced during withdrawal motivational states but impaired by approach states (each induced through the use of video clips) with the exact opposite pattern found for verbal N-Back performance (Gray, 2001). Research has also shown a clear association between the provision of motivational incentives such as monetary rewards, in comparison to no reward, and executive functions across various loads of the N-Back task (Pochon, Levy, Fossati, Lehericy, Poline, Pillon, Le Bihan, & Dubois, 2002; Szatkowska, Bogorodzki, Wolak, Marchewka, & Szeszkowski, 2008). Such findings not only provide much encouragement for the view that achievement goal states have the potential to affect working memory processing, but also that the N-Back task is a suitable task framework in which to examine such relations.

The present study aims to further understanding of the impact achievement goal states have on working memory. Firstly, a continuous working memory task (numerical N-Back) is employed to permit investigation of working memory processing under varying load. Investigation of load effects seems particularly important given that, as previously noted, some research illustrates motivational impact only under more cognitively demanding conditions. Secondly, experimental manipulation of goal states is executed according to chapter 2 meta-analytic findings and checks of manipulated goal states and goal recall are included (again, according to meta-analytic findings presented). Thirdly, with the aim of clarifying some previous ambiguity with regards to the preferential relations of either mastery or performance based states to cognitive performance, a no-goal state control group will be included in the current design.

Finally, to increase confidence in ruling out competing explanations, we include assessments of cognitive ability, state-anxiety and trait goal orientation to confirm that these variables do not differ between experimental conditions. Addressing these concerns will result in greater clarity as to whether the achievement goal states of mastery-approach and performance-approach influence working memory processing. From theory and previous research it is predicted that (1) achievement motivation states will influence working memory processing, that (2) such influence will diverge for mastery-approach and performance-approach conditions, and (3) that these differences will be most pronounced under high working memory load. Limited research, along with the general ambiguity and interpretative difficulties which characterises existing research, prevents specific directional predictions.

Method

Participants

Seventy-six University of London undergraduates (56 female) from various disciplines took part in the current research and all were entered into a £100 lottery in return for their participation. Age was recorded in 1 of 5 ranges (18-25; 26-35; 36-45; 46-55; 56-65) with a modal range of 18-25 years accounting for 55.3% of the sample. All participants had normal or corrected to normal vision. Informed consent was obtained prior to participation. Given that prior task knowledge or experience plays a significant role in freeing up more available working memory capacity to perform well, i.e., reduces the pressure on working memory (Ackerman & Kyllonen, 1991), it was deemed imperative to ensure that participants with significant previous experiences of the N-Back were excluded. However, no such participant was identified.

Working Memory

Working memory was assessed using a numerical N-Back task programmed using e-prime software (Schneider, Eschman, & Zuccolotto, 2002). The task required participants to indicate if the position of a currently presented stimulus matched or did not match the position in which a previous stimulus was presented, either one (1-back), two (2-back) or three (3-back) positions back in the presentation prior to the current stimulus (see figure 3.1). The test stimuli were single-digit numbers from 1 to 9, presented individually in pseudorandom order. Each number was displayed in the centre of a white background (in black Arial typeface size 48) for 1000 ms, followed by an interstimulus interval of 2750 ms. Participants responded with a ‘match’ or ‘not

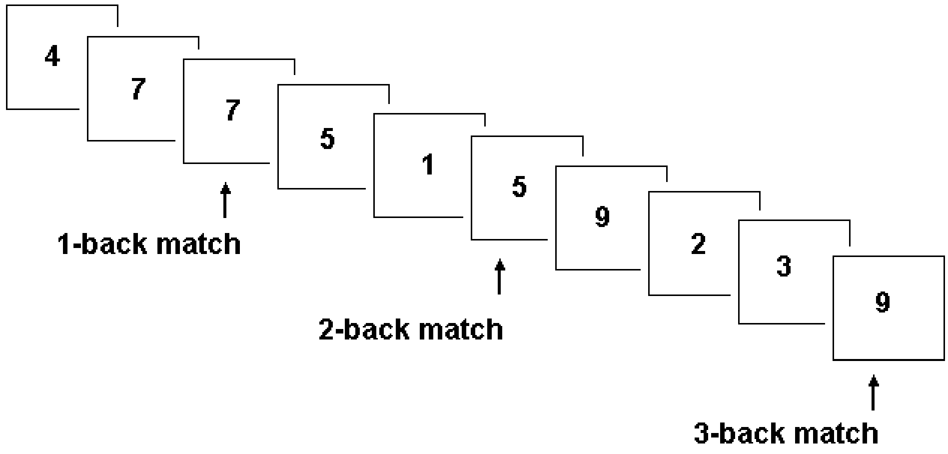

Figure 3.1. Integrated trial example of number matches from a 1-back, 2-back and 3-back load condition.

a match' key press during the 1000 ms presentation of the stimulus using the Z and M keys of a QWERTY keyboard respectively. Participants completed one practice block of each N-Back load (18 trials:12 non-matches, 6 matches), followed by six fully counterbalanced experimental blocks (2 blocks per N-Back load, each containing 30 trials: 20 non-matches,10 matches) (with matches being presented in random positions per block). Overall accuracy was calculated by summing the number of correct hits (correctly identifying a 'match') and correct rejects (correctly identifying a 'not a match') per N-Back load.

Manipulation of Achievement Goal States

The N-Back was performed in one of three experimental conditions: mastery-approach goal (MAG), performance-approach goal (PAG) or no-goal (NG). Achievement goals were manipulated according to meta-analytic findings presented in chapter 2, i.e., via instructions that framed the focal task (N-Back) in terms of an explicit normative or self-referential task purpose and goal frame. In addition to standard task instructions, participants in the MAG condition read the following standardised instructions prior to starting the first experimental block:

"The purpose of this study is to provide students with the opportunity to improve their own memory ability. As such, your goal whilst performing this memory task is to focus on learning how to detect correct number matches well. Developing your own proficiency on the memory task is the aim of the game!"

In contrast, in addition to standard task instructions, those in the PAG condition read an alternative set of standardised instructions prior to starting the first experimental block:

"The purpose of this study is to provide students with the opportunity to demonstrate their memory ability in comparison to other students. As such, your goal whilst performing this memory task is to detect as many correct number matches as you can in order to perform better than other students taking part. Being more proficient on the memory task than other students is the aim of the game!"

Participants in the NG condition were not given any further instructions relating to the purpose of the task beyond that of standard task instructions.

To facilitate the maintenance of induced motivational states, participants in both of the goal conditions were provided with associated goal prompts (via the computer screen) at the start of each block of the task. These consisted of reminders to ‘*develop their skill at the game*’ (MAG) or to ‘*perform better than other students’* (PAG). Those in the NG control were given no goal prompts.

Control Measures

Trait Goal Orientation. The approach scales from Elliot and Murayama’s (2008) Revised Achievement Goal Questionnaire consisting of 3 items per trait goal orientation dimension, was used to assess pre-existing differences in trait goal orientation amongst the participating students. The mastery-approach orientation scale (α = .70) consists of items such as “generally, my aim is to completely master material I am presented with”, while the performance-approach orientation scale (α = .80) consists of items such as “generally, my goal is to perform better than other students”. Participants responded on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*).

Working Memory Capacity. The Operation Span (OSPAN) task (Turner & Engle, 1989) was used to assess individual differences in working memory capacity. OSPAN requires the participant to solve a series of mathematical operations whilst also attempting to memorise unrelated words. Participants view operation strings one at a time and are required to read each string out loud (e.g., “Is (9 ÷ 3) - 2 = 2 ? AUNT”). Operation strings are presented at centre fixation in black New Times Roman font size 48 on a white background. The participant states the mathematical string, followed by verification of the answer (i.e., “yes” or “no”), followed in turn by the word (i.e., “aunt”). Operation strings ranged from sets of two to five (three of each set presented randomly) and once the end of each set was reached participants were required to recall the sequence of words stated. OSPAN scores ranged from 0-42, calculated by summing the total number of recalled words only on perfectly recalled sets. To ensure participants were not trading off mathematics for word recall, an 85%

accuracy criterion on the mathematics was required[13]. This original version of OSPAN is found to correlate with other capacity tasks, be highly reliable and demonstrate good internal consistency (see Conway et al., 2005).

Cognitive Ability. Ravens Advanced Progressive Matrices (1990) (RAPM), was utilised to control for general reasoning ability. Given that RAPM performance has previously been found to correlate with N-Back performance (e.g., Gray, Chabris, & Braver, 2003) the inclusion of this measure was considered important. Participants are presented with a matrix of geometric patterns with the bottom right pattern missing and are required to select from eight possible options the pattern that correctly completes the overall series of patterns. In a practice round, participants completed 4, of a possible 12, matrices from RAPM Set 1 to familiarise themselves with the task. For the actual test, participants completed 18 matrices from RAPM Set 2 (all odd numbered matrices from the original 36 set) in which matrices were presented in ascending order of difficulty. A manual guideline of 30 minutes is recommended for completion of 36 matrices when conducted under time restrictions, which was reduced to 15 minutes for the current research in accordance with the use of exactly half of the 36 matrices available. Participants recorded their responses on an answer sheet provided by noting, with a number from 1 to 8 per matrix, which of the 8 possible options they thought completed the matrix. Scores were based on the total number of correctly identified missing patterns (0, incorrect; 1, correct).

State Anxiety. A 5-item measure drawn from Ryan, Koestner and Deci's Intrinsic Motivation Inventory (1991) was used. This scale measures the extent to which individuals feel pressure in relation to a target activity. All items were adapted to the task at hand, for example, "I was anxious whilst doing this activity", became, "I

[13] All participants surpassed this accuracy criterion.

was anxious whilst doing this memory task”. The 5 items were rated on a 7 point scale ranging from 1 (not at all true) to 7 (very true) with an internal consistency reliability of .77.

Manipulation Checks

Goal Recall: Task Purpose. To confirm that participants understood the goal-related purpose of the task, at the end of the experiment participants were asked to tick from a list provided, what the purpose of the task they had just completed was. Options included ‘to provide me with the opportunity to develop my own memory ability’ (MAG), ‘to provide me with the opportunity to demonstrate my memory ability in comparison to other students (PAG), and additionally, ‘I don’t remember the purpose of the memory task’, and ‘the purpose of the memory task was not made clear to me’ to capture any misunderstanding.

Goal Recall: Goal Assigned. To confirm that participants understood the specific goal assigned to them they were also asked to tick from a list provided, what was the specific goal you were assigned for the memory task you just completed including, ‘to develop my own proficiency on the memory task’ (MAG), and ‘to demonstrate that I am more proficient on the memory task than other students’ (PAG), and additionally, ‘I was assigned no goal’ and ‘I did not understand the goal assigned to me’ to capture any misunderstanding.

Goal State. In order to assess whether the goal manipulations had the desired effects on achievement motivation, a measure of state goals was also taken. State adapted forms of the mastery-approach and performance-approach scales from Horvath, Scheu and DeShon’s (2001) Global Goal measure were utilised. The mastery-approach scale ($\alpha = .72$) consists of 4 items such as ‘The opportunity to learn new things on this memory task was important to me'. The performance-approach scale (α = .91) consists of 4 items such as 'It was important to me that I performed better than other students also doing this memory task'. Participants read 'As I started and during the memory task….' prior to completing the items. Responses were scored on a scale from 1 (*strongly disagree*) to 5 (*strongly agree*). It was made clear to all participants that responses were to be based on the experimental blocks only.

Procedure

Participants were tested individually in a sound proof laboratory. Upon arrival participants were seated at a computer desk and told they would be performing some memory tasks and completing some questionnaires. Written consent was obtained and demographic and trait goal orientation items were completed. Participants then completed the OSPAN and RAPM assessments in a counterbalanced order, after which they were given a 5 minute break (but remained in the testing room). After completing the practice blocks of the N-Back, participants read the relevant instructions for their achievement goal condition, before moving on to the experimental blocks. All participants worked through the experimental blocks at their own pace by following on screen instructions. The experimenter remained in the testing room across all conditions, but sat quietly at the back of the room, out of participant sight. No feedback during experimental blocks was provided so as not to conflict with the goal states being manipulated. After completing the six experimental blocks all participants completed (in counterbalanced order) the questionnaires assessing task purpose, goal assigned, goal state, and state anxiety. (Those in the control group did not complete the purpose or goal assigned manipulation check.) Finally, all participants then received a thorough debriefing on the purpose of the experiment and were thanked for their participation. This entire procedure lasted approximately 90 minutes.

Results

Manipulation Checks

Chi-square tests of independence revealed that participants' post-task reported purpose, χ^2 = 42.33, *df* = 3, *p* < .001, and assigned goal, χ^2 = 38.81, *df* = 3, *p* < .001, was consistent with their experimental condition. Thus confirming that participants in both the MAG condition and the PAG condition correctly recalled and understood their assigned manipulations. In terms of motivation states, there were significant differences in reported state mastery-approach across groups, *F*(2,73) = 6.334, *p* = .003, with participants in the MAG condition (*M* = 15.72, *SD* = 1.72) scoring significantly higher in this state than those in the PAG condition (*M* = 14.28 , *SD* = 2.96), *t*(48)= 2.10, *p* = .041, and than those in the NG control condition (*M* = 13.08, *SD* = 3.04), *t*(49)= 3.80, *p* < .001). Participants in the PAG condition scored the highest on the state performance-approach scale (*M* = 10.28, *SD* = 4.45) compared to participants in the MAG (*M* = 8.68, *SD* = 3.91) and NG (*M* = 8.88, *SD* = 4.54) condition, however this did not reach statistical significance, *F*(2,73) = 1.02, *p* > .05. For one item of the state performance-approach motivational scale (Horvath et al., 2001) which specifically asked whether participants enjoyed the sense of proving their memory ability in comparison to others doing the task, there was a near significant difference between the two key achievement goal conditions. Those in the PAG (*M* = 3.00, *SD* = 1.18) agreed more strongly with this item in comparison to those in the MAG (*M* = 2.12, *SD* = 1.05), *t*(48)= 1.80, *p* = .08. No significant relations between either self-reported state mastery-approach or performance-approach scales and state-anxiety were found (*both ps* >.40), suggesting that experienced anxiety was unlikely to influence the pattern of manipulation check results.

Preliminary Analyses

Descriptive statistics for key variables within each goal condition are presented in table 3.1. Table 3.2 contains the proportion of correct hits and overall accuracy by experimental condition. Correlations between key variables are presented in table 3.3. Age was found to be elevated among participants in the MAG group (*M* = 2.0, *SD* = 1.3) in comparison to the PAG (*M* = 1.4, *SD* = .64) and the NG group (*M* = 1.7, *SD* = .91). In addition, pairwise t-tests revealed influences of age on N-Back performance on some loads ($p < .05$). As such, age was included as a covariate in all main analyses. No effect of gender or block load order was found (*all p*'s > *.30*), and no group differences for overall accuracy in practice N-Back blocks were identified ($p = .83$) indicating that goal groups did not significantly differ on N-Back performance at baseline. Further analyses revealed that goal groups did not significantly differ on trait mastery-approach ($p = .74$), or trait performance-approach ($p = .85$), or state-anxiety ($p = .78$), suggesting it to be unlikely that these variables could explain any possible group effects. As also expected given the details outlined in the procedure, goal groups didn't differ on cognitive ability ($p = .33$) or working memory capacity ($p = .98$). Trait mastery-approach was found to negatively correlate with 2-Back accuracy ($r = -.23$), suggesting those higher in this trait performed more poorly in the 2-Back conditions. Also, trait mastery-approach shared a positive relation with state-anxiety ($r = .25$) suggesting that this dispositional focus promoted less of a relaxed approach.

Table 3.1. Means and Standard Deviations for Study 2 Variables by Condition

	Mastery-Approach		Performance-Approach		No-Goal Control	
	M	*SD*	*M*	*SD*	*M*	*SD*
Trait Mastery-approach	12.80	2.00	13.12	1.53	12.77	1.79
Trait Performance-approach	10.20	3.21	10.64	3.29	10.60	3.19
Cognitive Ability	10.76	3.45	10.20	2.67	11.46	2.85
Working Memory Capacity	18.44	10.04	17.84	10.74	18.00	11.02
State Anxiety	16.56	6.10	16.20	5.60	15.40	6.47
1-Back Average Reaction Time	649.96	89.37	681.25	82.13	649.31	83.45
2-Back Average Reaction Time	689.77	91.97	713.11	88.53	674.34	81.10
3-Back Average Reaction Time	721.38	86.98	733.47	96.97	697.03	74.87

Note: Mastery-Approach, N= 25; Performance-Approach, N= 25; No-Goal Control, N= 26. Means are not adjusted.

Table 3.2. Proportion of Correct Hits and Overall N-Back Accuracy by Condition

	Mastery-Approach	Performance-Approach	No-Goal Control
1-back:			
Correct Hits	.87	.85	.89
Overall Accuracy	.85	.86	.89
2-back:			
Correct Hits	.71	.66	.76
Overall Accuracy	.72	.71	.78
3-back:			
Correct Hits	.54	.41	.55
Overall Accuracy	.63	.54	.67

Note: Mastery-Approach, N= 25; Performance-Approach, N= 25; No-Goal Control, N= 26. Correct Hits: correct matches identified. Overall Accuracy: correct matches and correct non-matches identified.

Table 3.3. Intercorrelations Among Key Study 2 Variables

Variable	1	2	3	4	5	6	7	8	9	10
1. 1-Back Accuracy	-									
2. 2-Back Accuracy	.57**	-								
3. 3-Back Accuracy	.47**	.73**	-							
4. Trait Mastery-Approach	-.01	-.23*	-.18	-						
5. Trait Performance-Approach	.01	-.09	-.08	.12	-					
6. State Mastery-Approach	.05	.06	.01	-.09	-.05	-				
7. State Performance-Approach	.02	.07	.09	.02	.48**	.04	-			
8. Cognitive Ability	.01	.13	.09	.02	.01	-.21	.15	-		
9. Working Memory Capacity	-.01	-.07	-.06	-.09	.08	.09	.20	.23*	-	
10. State-Anxiety	-.01	-.15	-.14	.25*	.04	-.09	.09	.06	-.26*	-

*Note: *p<.05 **p<.01.* State mastery-approach and state performance-approach are the post-task self-reported forms.

Given that trait mastery-approach was not found to differ between experimental groups this was not deemed to pose any particular threat. Finally, response reaction time analyses revealed that all participants got slower in responding to stimuli as N-Back load increased, $F(2,146) = 26.62$, $p < .001$, with response reaction time for 1-back being significantly quicker than in 2-back ($p < .001$), and 2-back being significantly quicker than 3-back ($p = .003$), indicating the manipulation of working memory load to have been effective. However, no effect to indicate that response reaction time across N-Back loads differed between goal groups was found ($p = .77$).

Effect of Motivational State on Working Memory

A 3 x 3 mixed ANCOVA was conducted with goal group (MAG, PAG, NG) as the between-subjects factor, N-Back load (1, 2 and 3-back) as the within-subjects factor, and age as a covariate. There was no significant main effect of goal group, $F(2,72) = 1.89$, $p = .16$. There was a significant main effect for load, $F(2,144) = 9.43$, $p < .001$, with estimated marginal means of 52.10, 44.19, and 36.81 for 1-back, 2-back and 3-back loads respectively. Accuracy for all participants decreased as N-Back load increased with 1-back accuracy being significantly higher than 2-back overall accuracy, $F(1,72) = 6.28$, $p = .014$, and 2-back accuracy being significantly higher than 3-back accuracy, $F(1,72) = 3.82$, $p = .05$. There was also a significant load x goal group interaction, $F(4,144) = 3.03$, $p = .02$, indicating that differences in accuracy over the three N-Back loads depended upon manipulated goal.

In accordance with predictions, a series of one-way ANCOVAs conducted to follow up the significant two-way interaction revealed no significant effects of goal group for 1-back ($p = .56$) or 2-back ($p = .32$) accuracy, but a significant effect of goal group for 3-back accuracy, $F(2,72) = 4.20$, $p = .019$, $\eta_p^2 = .10$ (see figure 3.2). No significant differences in 3-back accuracy were found between participants in the MAG and NG group. However, (conducted using Bonferroni adjusted alpha level of .025) participants in the PAG group had a significantly lower 3-back accuracy (M = 31.50) than those in the NG group (M = 40.44), $t(72) = -2.80$, $p = .007$, but given adjusted alpha levels, although on average 3-back accuracy of those in the PAG group was lower than those in the MAG group (M = 38.48), this was trending above the adjusted alpha level, $t(72) = 2.12$, $p = .037$.

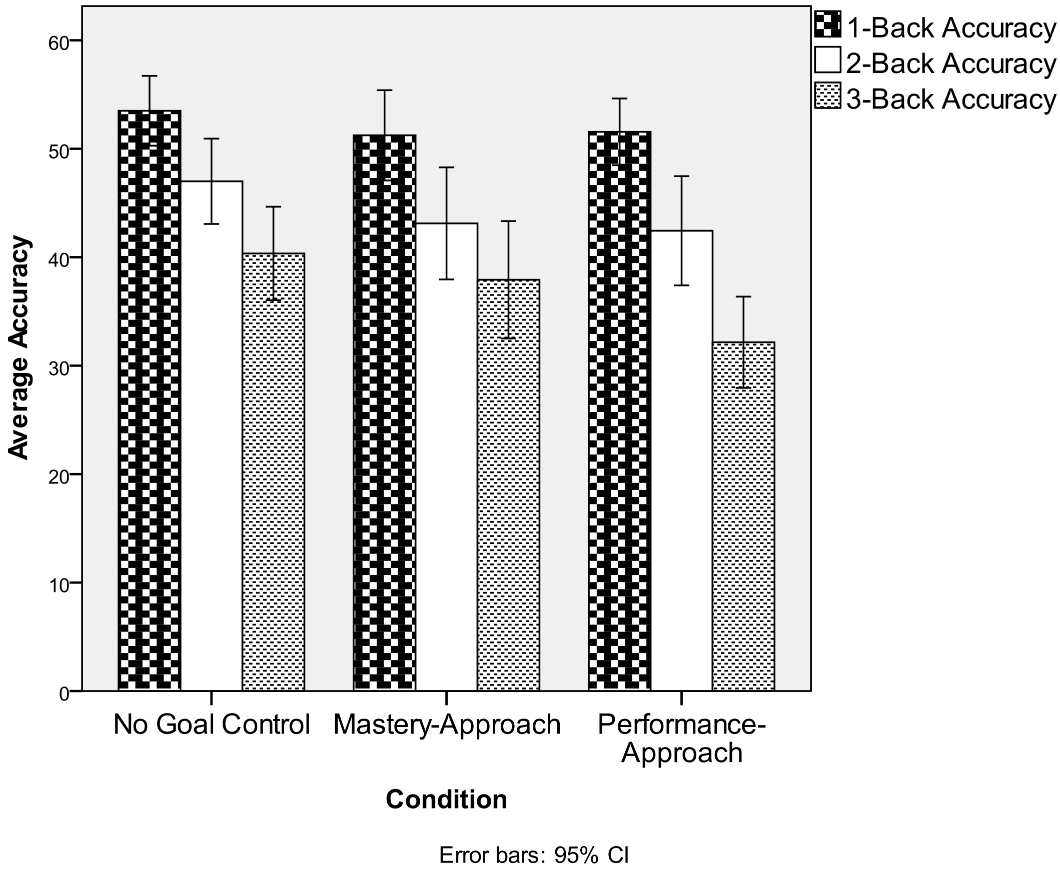

Figure 3.2. Average overall accuracy for each N-Back load by condition

Although groups were not found to differ on trait mastery-approach or trait performance-approach, possible state-trait interactions were considered. However no such significant interactions were identified.

Discussion

The present study examined how motivational states differentially impact upon working memory. It was found that inducement into a performance-approach state influenced working memory processing under high load, as shown by poorer N-Back task performance compared to participants in a mastery-approach and no-goal control condition. Consistent with some previous research (Barker et al., 2002; Graham & Golan, 1991; Wegge et al., 2001), these effects were restricted to the greatest executive load of the N-Back (3-back). The pattern of post task manipulation checks confirmed that participants' goal recall and reported goal state corresponded to their assigned achievement goal condition. The present findings are highly unlikely to be confounded by differences in cognitive ability, working memory capacity, state-anxiety or trait goal orientation preferences. Findings therefore engender greater confidence than previous research (DiCintio & Parkes, 1997; Linnenbrink et al., 1999; Parkes et al., 1998) of the potential impact that achievement goal states have on working memory processing. Findings will now be discussed and implications for the study to be presented in the next thesis chapter will be continually outlined.

No task performance differences on 1-back or 2-back loads were found between experimental groups. This suggests that induced achievement goal states, (compared with a no-goal control condition), don't influence working memory processing when the need to monitor, update, store and discard items in working memory is less demanding. Although this is inconsistent with some research which has shown that performance-approach demonstrates superior task performance under less demanding conditions (Mangos & Steele-Johnson, 2001; Steele-Johnson et al., 2000; Winters & Latham, 1996), it is fitting with the majority of findings which tend not to find achievement goal differences in less demanding conditions in comparison to the more effortful (Barker et al., 2002; Graham & Golan, 1991; Murayama & Elliot, 2011). Furthermore, the fact that an effect was found under the highest N-back load, and not under the less working memory intensive loads, suggests specific relevance to working memory processing specifically as opposed to more general aspects of task performance.

Poorer performance of those induced into a performance-approach state in the 3-back load may sit comfortably alongside research suggesting that performance-approach goal pursuit is characterised by more superficial cognitive engagement (Bereby-Meyer & Kaplan, 2005; Elliot et al., 1999; Escribe & Huet, 2005; Wolters, 2004) and that such goal pursuit only tends to produce good cognitive performance under less demanding conditions (Mangos & Steele-Johnson, 2001; Steele-Johnson et al., 2000; Winters & Latham, 1996). These present findings suggest that a motivated focus to demonstrate one's competence relative to others perhaps restricts/limits working memory processing at higher loads. Interestingly, although previous findings suggest that approach relative to withdrawal based motivational states, are likely to differentially influence working memory (Gray, 2001), the present research has shown that consideration of qualitatively different forms of approach states also has the potential to produce differential effects. This illustrates the worth of investigating different forms of approach states - such as different aims or foci of approach states, beyond the valence or direction of a state - in broadening understanding of the motivation-cognition interface.

Importantly, present findings outline that a mastery-approach goal focus didn't significantly differ from a no-goal control in influencing working memory. Although much research has shown the benefits of this motivational state in terms of superior cognitive strategy use and recall (Bereby-Meyer & Kaplan, 2005; Escribe & Huet, 2005; Graham & Golan, 1991) and working memory *capacity* (DiCintio & Parkes, 1997; Linnenbrink et al., 1999; Parkes et al., 1998) some of these studies failed to include a control group. It is therefore difficult to conclude from these studies whether a mastery-approach goal *enhances* working memory function, or does not impair working memory function to the same extent as a performance-approach goal focus. In contrast, what can be suggested from the present findings is that those focused on developing competence seem to maintain working memory processing under a demanding task condition more effectively than those asked to focus on demonstrating competence.

Previous research has clearly documented the cognitive advantages of being in a focussed or heightened motivational state (Bargh et al., 2001; Hassin et al., 2009; Heitz et al., 2008; Wegge et al., 2001). The present findings appear in stark opposition to this, as those in a no-goal control condition enjoyed the highest average overall accuracy across all three N-Back loads. Given that the no-goal control group reported the lowest state levels of mastery-approach and performance-approach, as expected, it is difficult to attribute their superior performance to self-adopted achievement goal states. Interestingly, this control group advantage is consistent with previous findings illustrating no achievement goal benefit when working memory processing (assessment of continuous processing), rather than capacity (set-based span measures typically used to assess individual differences), is examined (Parkes et al., 1998).

It is therefore possible that having no specifically assigned achievement goal frees working memory resources that would have otherwise been consumed by representation of an assigned achievement goal (i.e., controls were less distracted as they received less information regarding how they should have been performing the task or any form of potentially distracting motivational prompts between task blocks relative to the other goal conditions). Previous research demonstrating benefits of assigned motivational goals above no goal assigned provided very specific target based goals (i.e., 'recall at least 18 out of 24 words'; Wegge et al., 2001), whereas the current achievement goal inducements targeted very broad forms of task purpose and goal focus (i.e., 'develop your ability….by learning how to detect number matches well'), consistent with the achievement goal literature (Elliot et al., 2005). Potentially, such a broad task purpose and goal frame focused manipulation is not sufficient for eliciting strong effects on performance. Unfortunately, a lack of appropriate data in the previous meta-analytic chapter didn't allow for specific examination of different forms of task purpose and goal frame based manipulations (the combined manipulation methodology found to be most effective). However, another key aim for the next chapter study is to compare the effects of goal states with more task(target)-specific forms of the goal frame manipulation element.

Unlike previous research in this area (Barker et al., 2002; DiCintio & Parkes, 1997; Graham & Golan, 1991; Linnenbrink et al., 1999; Parkes et al., 1998), several competing hypotheses can be ruled out due to the assessment of various important nuisance variables. No group differences in the present research were found in trait achievement goal preferences, cognitive ability, working memory capacity and state-anxiety. This provides some certainty in the limited role that more stable preferences for either demonstrating or developing competence in achievement settings, and indeed that of more stable attentional capabilities, played in the observed state group differences. This is also particularly important, as previous research has implicated anxiety in the differential relations of achievement goals to working memory by suggesting that performance-approach disrupts the *use* of working memory resources through heightened anxiety (DiCintio & Parkes, 1997; Linnenbrink et al., 1999; Parkes et al., 1998). The present research however suggests that effects are evident despite there being no between group differences in state-anxiety. Interestingly, Kanfer and Ackerman (1989) suggest that attentional resources can be selectively allocated partially or fully to achieve current goals. Accordingly, it is possible that performance-approach states manipulate more selective reliance on available attentional capacity, rather than disrupted allocation. Unfortunately it is difficult to confidently draw this conclusion from the present results, as although the N-Back task assesses working memory processing (rather than capacity), present data would not enable specific and selective working memory strategies to be identified. Thus, a key feature of the next chapter study, in order for this research area to progress, is a more detailed task analysis of working memory paradigms.

Although the pattern of goal recall and motivational state checks indicated successful inducement of state mastery-approach and performance approach, participants in the performance-approach condition did not report being significantly higher in this state in comparison to those in the other two conditions when considering responses to the entire Horvath et al. (2001) state performance-approach scale. There may be several reasons that this effect, although trending in the expected direction, did not reach significance. It is possible that participants were reluctant to report that they wanted to 'outdo others' or that they wanted to be 'recognised as having the best memory ability', which is arguably slightly less desirable than reporting a desire to simply 'get better at the task', or indeed than reporting a 'sense of enjoying trying to do better than others'. This point receives some support from the fact that on one particular item of the state performance-approach scale (Horvath et al., 2001) which evaluated the experience of performance-approach rather than directly getting participants to agree to have wanted to outperform others, a close to significant effect was observed. Those in the performance-approach condition more strongly agreed that they enjoyed the sense of trying to prove their ability in comparison to others, relative to those in the mastery-approach condition. It is possible therefore that state performance-approach was somewhat deflated due to biases in reluctant reporting as just described. This would account for why participants in this condition significantly and correctly recalled and understood their assigned task purpose and goal, why on one key motivational state check item which addressed enjoying the sense of proving ability in comparison to others, a very near to significant effect emerged, but why on those items which more directly asked participants whether they wanted to be recognise as having the best memory ability for example, only a pattern of desired effects lacking in statistical significance emerged.

It is possible that these different features just discussed of the scale employed to measure goal states could have also contributed to the lack of observed significance for state performance-approach in other ways. For example, although most of the Horvath et al. (2001) performance-approach items were consistent with the content provided in the introductory task inducement paragraphs (i.e., focused on performing better than others), only one item (interestingly the one item found to differentiate achievement goal conditions most predominantly) actually included a reference to ‘ability’. The other three items referred more generally to 'performing' better than others. The method used to manipulate achievement goal state made specific references to ‘demonstrating memory ability’ for those in the performance-approach condition. There may therefore have been some weakness in the utility of the entire scale for confirming whether a participant was actually in a state of demonstrating competence in accordance with the manipulation methodology content. This links somewhat to the point that a lack of significance for the entire state performance-approach scale may demonstrate the modest power of the specific inducement method used in the current study. The lack of an objectively attainable performance standard (as previously mentioned in this discussion) or feedback on whether normatively superior performance was actually being achieved, may have weakened participants perceptions of their experience of a performance-approach state, reflected in their responses to post-task goal state measures. Given the previous chapter findings justifying the chosen post-task manipulation checks and procedure, it is exactly this final point above that will be addressed in the next chapter study, rather than changing the type of, or procedure of, post-task manipulation checks.

In sum, the present research has shown that manipulated achievement goals influence working memory processing. Pursuit of a performance-approach goal seems to result in poorer processing under higher executive demand in comparison to pursuit of a mastery-approach goal and no assigned goal. This performance-approach deficit is unlikely to be confounded by related individual differences in ability, capacity or experienced state-anxiety. The present results arguably provide some explanatory ground for previously observed relations between performance-approach and less effective cognitive strategy use, as well as for why superior performance is often limited to the less cognitively demanding situation (Bereby-Meyer & Kaplan, 2005; Escribe & Huet, 2005; Mangos & Steele-Johnson, 2001; Steele-Johnson et al., 2000; Winters & Latham, 1996). The illustration that such simple motivational inducements, common in many applied contexts such as the classroom and workplace, influenced working memory processing clearly justifies and demands the need for more specific examination of the achievement goal-working memory relationship.

CHAPTER 4

Study 3

Overview of Chapter

The purpose of this chapter is to build on the findings of chapter 3 using a dual-task approach. It will do so by employing an experimental design that allows for the examination of the influence of a secondary working memory task, varying in load, on a primary achievement goal pursuit task. The differential impact of this secondary task for different goal state groups will then establish the extent to which the states of mastery-approach and performance-approach rely upon working memory resources. The use of dual task methodology to 'measure' reliance upon attentional resources will be briefly reviewed before the specific employment of a 'game' based primary achievement goal pursuit task is outlined. Points based target specific forms of task purpose and goal frame based manipulations are used in the present study in order to address some of the concerns relating to manipulation effectiveness and performance effects as noted in the discussion section of the previous chapter 3. Again, research findings are presented and discussed specifically in line with the implications for the design of the experimental work to be presented in subsequent chapters.

Background Review

Findings from the previous chapter provide some initial indication that achievement goal states influence working memory. Specifically, the findings from chapter 3 revealed that those in a performance-approach condition had poorer working memory performance when the task was highly demanding relative to those in the mastery-approach condition. However, the mastery-approach condition offered no advantage over a control condition, suggesting a disadvantage of a performance-approach focus rather than an advantage of a mastery-approach focus. Also, as those in the control condition enjoyed the highest average overall accuracy across all three N-Back loads, it appeared that those in this condition had more 'freed' working memory resources that would have otherwise been consumed by representation of an assigned achievement goal. It seems imperative to further address the extent to which these previous chapter findings might be explained in terms of the role of working memory in achievement goal pursuit, i.e., to what extent does a mastery-approach and performance-approach state differentially utilise/rely upon working memory resources for effective goal pursuit.

Dual task methodology is a widely researched and extensively used technique for assessing the extent to which attentional resources might be engaged in a particular task of interest. This methodology involves performing two tasks simultaneously, or two interleaved tasks, with a distinction between a primary and a secondary task of interest. Depending upon the aims of the research, decrements in the primary task of interest when also performing the secondary task, is argued to result from the resource capacity that remains from that consumed by the secondary task (O'Donnell & Eggemeier, 1986). In relation to working memory, the demand of a secondary working memory task will compete with a primary task for working memory resources to the extent that the primary task actually requires working memory for successful performance (Baddeley, 1986).

As outlined in chapter 1, dual-task designs have clarified the fractionation of working memory (Barnes, Nelson, & Reuter-Lorenz, 2001; Hitch & Baddeley, 1976; Logie, Zucco, & Baddeley, 1990), but also the role of working memory in various other primary tasks/processes of interest (De Beni, Pazzaglia, Gyselinck, & Meneghetti, 2005; McKinnon & Moscovitch, 2007; De Fockert et al., 2001; Phillips, Channon, Tunstall, Hedenstrom, & Lyons, 2008; Rosen & Engle, 1997). For instance, Aarts and Dijksterhuis (2000) examined the influence of secondary working memory load requiring participants to report the sum of two digits presented on screen during a goal-response primary task in order to assess the extent to which associating a response to an assigned goal demands attention. Also, in attempts to examine whether self-regulation (initiated through goal setting) requires attentional resources, researchers have used memorisation based secondary tasks varying in the number of stimuli (varying in load) to be remembered (i.e., recalling between 3 and up to 9 digits) (Deshon et al., 1996). In doing so, the ability to perform both the goal pursuit task (e.g., 'do your best on this task', or, 'to achieve a performance criterion of X') and the memorisation task, can be examined as an indication of whether (or by how much) such goal pursuit is dependent upon attentional resources (Deshon et al., 1996). Interestingly, Deshon et al. (1996) found that participants assigned difficult, specific goals performed at least as well on a secondary memorisation task, in addition to a primary goal pursuit, as did those pursuing 'do your best' goals. Thus, these particular dual-task findings suggested no differential reliance upon attentional resources between different types of goals per se, rather that assignment of any goal will demand some resources.

Memorisation based secondary tasks have also varied in form. Some experimental designs require participants to report whether a single probe presented at the end of trial was present or absent from a previously presented stimulus set at the start of a trial (Chee & Choo, 2004). Other designs require participants to report whether a probe proceeds any of stimuli presented in a previous set (e.g., the letters b and j are presented, with a probe of c; c proceeds b) (also see Chee & Choo, 2004). Lavie and De Fockert (2005) employed a 'successor naming' concurrent working memory task to examine the role of working memory in attentional capture. This successor naming task involves the presentation of four digits at the start of a trial and requires participants to respond to a single memory probe presented at the end of the trial by indicating what digit followed the probe presented in the earlier presented set. Such designs also allow researchers to easily manipulate the load of the secondary task, with digit order remaining fixed on all trials in low working memory load conditions (e.g., 01234), but, presented in random order on each trial in high load conditions (e.g., 04231) (Lavie & De Fockert, 2005).

To the author’s knowledge, no research has employed memorisation based dual task methodology in investigating any relations of achievement goals. This approach certainly provides much potential for examining the extent to which mastery-approach and performance-approach goal pursuit relies upon working memory resources. In particular, examining the influence of both high and low secondary working memory load on a primary achievement goal pursuit task will shed light on the extent to which these goal states might actually rely upon working memory. To successfully investigate this it was important to address some of the following issues: Firstly, the primary goal pursuit task needed to be trial based in order to allow for the secondary working memory task to be interleaved. Secondly, that such a primary goal pursuit task needed to be one for which goal manipulations could be easily applied, and finally for which varied working memory engagement was possible. In other words, a primary task which is not totally working memory dependent per se (as secondary load would deplete primary performance entirely limiting the detection of between group reliance differences), but a primary task within which varied working memory reliance could be detected.

A possible avenue here is to utilise games or puzzles, as these have been shown to draw on a range of cognitive processes including working memory. Games and puzzles are useful tasks in examining varied cognitive processes (particularly problem solving and working memory based) including for example, gambling and card games (Gozzi, Cherubini, Papagno & Bricolo, 2011), mazes (Paas, Camp, & Rikers, 2001; Sweller & Levine, 1982), word and arithmetic games (Kajamies, Vauras, & Kinnunen, 2010; Seyler, Kirk, & Ashcraft, 2003), video games (Basak, Boot, Voss, & Kramer, 2008), and planning tasks (Carder, Handley, & Perfect, 2008). For example, Robbins, Anderson, Barker, Bradley et al. (1995) examined the role of working memory in the game of chess by imposing various forms of continuous secondary, concurrent, tasks designed to block separate components of working memory whilst playing primary chess related games. This, for example, included the suppression of the articulatory loop through subvocal rehearsal, and by blocking the central executive by secondary random letter generation, in order to reach specific conclusions regarding the nature of cognition in chess (Robbins et al., 1995).

Games and puzzles provide an engaging environment for learning - argued to be perceived as fun, but challenging, and suggested to increase motivation and easily allow for manipulation of rules and goals (Kiili, 2005; Kim, Park & Baek, 2009). The use of games is also highly evident within the achievement goal literature, albeit from a more general task performance perspective rather than cognition specific. For example, state achievement goals were successfully induced on a computerised version of Tetris, a two-dimensional game in which geometric figures 'falling' down on screen have to be aligned by skilfully manipulating the figures positions on screen (Spinath & Steinsmeier-Pelster, 2003). Word games have also featured well in the achievement goal literature, including experimental manipulation of goal states on embedded and hidden word puzzles (Elliot & Harackiewicz, 1996), word searches in which participants have to find as many words as they can within a time limit

(Harackiewicz, Abrahams, & Wageman, 1987), word matching games (Steele-Johnson et al., 2008), and letter matrix games in which participants have to connect adjacent letters in a matrix to make as many words as possible (Senko & Harackiewicz, 2005a). Although task performance findings from these studies have been mixed in terms of goal state advantage, these games have proved useful frameworks within which to manipulate mastery-approach and performance-approach states and observe between group effects.

The primary game being utilised in the present study is a word finding game (based loosely on the *Parker Brothers* game Boggle^{TM}). On each trial, participants are presented with a 4 x 4 letter matrix and required to make as many words as possible (described in detail in the method section). Although, to the author's knowledge the role of working memory in this specific game has not been researched, other related findings provide some insight here in terms of the relevance of this task for the current study design needs and aims. Working memory has been implicated in playing a key role in allowing the flow of information about words from long-term memory into immediate memory with the aim of finding word combinations in the similar game of *scrabble,* for example (Halpern & Wai, 2007). However, when playing scrabble and other *word formation* based games, research illustrates that strategies varying in working memory dependency can be employed. For example, detection of shorter relative to longer word lengths (either being visually or verbally maintained and manipulated) and the strategic use of additional variations of words (e.g., use of letter 's' or 'ed', or, changing the first letter of a word such as 'cat', 'hat', 'bat', rather than proceeding to form entirely 'new' words) (Cansino, Ruiz, & Lopez-Alonso, 1999; Halpern & Wai, 2007; Senko & Harackiewicz, 2005a), could all represent 'attention investment' differences in playing the game.

Thus, the present study aims to employ dual task methodology, consisting of the interleaving of a word game (primary goal pursuit task) with a secondary working memory task load (low, high) to examine the role of working memory in state achievement goal pursuit. If the primary achievement goal pursuit requires/engages working memory resources, then word game performance will decline from low to high working memory load. This effect will be larger for the goal state which engages working memory more, i.e., secondary load will interfere most with the goal state which relies more on working memory resources. As such, if pursuing a mastery-approach goal during a game fosters heavy reliance upon working memory resources to do well (i.e., demands access to such resources), then primary task performance should be substantially disrupted by high secondary load. In contrast, if pursuing a performance-approach goal limits working memory engagement, i.e., reliance upon less working memory intensive strategies for goal pursuit, then there are two possible outcomes. Firstly, if reliance on less working memory resources by performance-approach is due to a disruption of available resources, then, primary task performance under high load should be depleted as the secondary task would consume the only limited available resources remaining from goal disruption. However, if limited working memory engagement is more selectively used, or perhaps under utilised (i.e., working memory is available but less favoured during performance-approach pursuit), then the presence of a high secondary load should have little influence on primary task performance.

These propositions are investigated in order to increase understanding of the achievement goal-working memory relationship. Specifically in addressing some of the concerns noted in the discussion of the previous chapter 3 study, the present study firstly aims to employ a dual task design, which allows for a more specific examination of the role of working memory in achievement goal pursuit. Secondly, as noted in the discussion section of the previous chapter 3, manipulations which refer to specific, points based, targets will be employed. Thirdly, Goal Recall and Goal State checks, a no-goal state control group, assessments of cognitive (verbal) ability, state-anxiety and trait goal orientation are also all included. Task relevant measures of cognitive ability are particularly important given that highly able individuals are much less likely to suffer depletion of attentional resources when cognitive load is increased (Sweller, Van Merriënboer, & Paas, 1998). It is predicted that a) working memory will play a differential role in the pursuit of a mastery-approach goal relative to a performance-approach goal as previously proposed, b) this difference will emerge as primary task performance declines under low to high secondary working memory load, and c) such decline will be larger for the goal state for which working memory plays a more vital role.

Method

Participants

Two participants failed to reach above the 85% accuracy criterion on the OSPAN task and thus their data was removed from analyses[14]. This left seventy-three University of London undergraduates (47 female) from various disciplines who took part in the current research and all were paid £5 for their participation. Age was recorded in 1 of 5 ranges (18-25; 26-35; 36-45; 46-55; 56-65) with a modal range of 18-25 years accounting for 75.3% of the sample. All participants had normal or corrected to normal vision. Informed consent was obtained prior to participation.

[14] Removal of these participants didn't affect the pattern of results reported.

Experimental Task

Participants performed an achievement goal pursuit task under dual-task conditions programmed using e-prime software (Schneider et al., 2002). The primary task was a word game (based loosely on the *Parker Brothers* game Boggle™) whereby in each trial participants are presented with a 4 x 4 letter matrix and required to make as many words as possible in 20 seconds with no restrictions on letter locations but under the single rule that words must be a minimum of 3 letters long. The matrix is presented on the left hand side of a standard 15'' PC monitor, and on the right is a text box where participants are required to directly type in their word responses using a QWERTY keyboard. All 16 letters within each matrix presented were singular with the exception of 'Qu'. Each 16 letter matrix contained a minimum of 2 vowels and the remaining letters were any of the possible 21 consonants from the alphabet, with repetitions of the same letter in a single matrix permitted (see figure 4.1).

The word game was interleaved with a secondary task, the "successor naming" working memory task, which requires recall of digit order (as used by Lavie & De Fockert, 2005) (see figure 4.2). Thus, the word game was always performed under dual-task conditions. The presence of a secondary task in both low and high load conditions was specifically selected rather than investigating single (low load) versus dual task (high load) conditions which are not as directly comparable. At the start of each trial, prior to presentation of the 20 second word game, a memory set consisting of the digits 0, 1, 2, 3, 4 was presented for 1500 ms, centered at fixation. In the condition of low working memory load, the memory set was always presented in a fixed order of 0, 1, 2, 3, 4. However, in the high working memory load condition,

Figure 4.1. Example letter matrix.

the digit 0 always remained in the first position of the set but the order of the digits 1-4 was varied at random on each trial. Memory sets were followed by a 1500 ms fixation interval in both low and high load conditions, which was then followed by presentation of the 20 second[15] word game. Following the word game, a memory probe appeared and remained on screen until a response was made or 3000 ms had elapsed. The memory probe presented one digit to the left of a question mark centered at fixation, equally likely to be either 0-3 in the low load condition or 0-4 in the high load condition. Participants were required to key-in the digit that followed the probe digit in the memory set they had seen prior to the word game for that trial using the corresponding 1-4 number keys of a QWERTY keyboard. All of the positions in the memory set were likely to be probed across trials. Following a response to the

[15] This particular period of time was primarily set to ensure that the probe following the word game was reliably 'probing' the presence of the stimulus set in working memory.

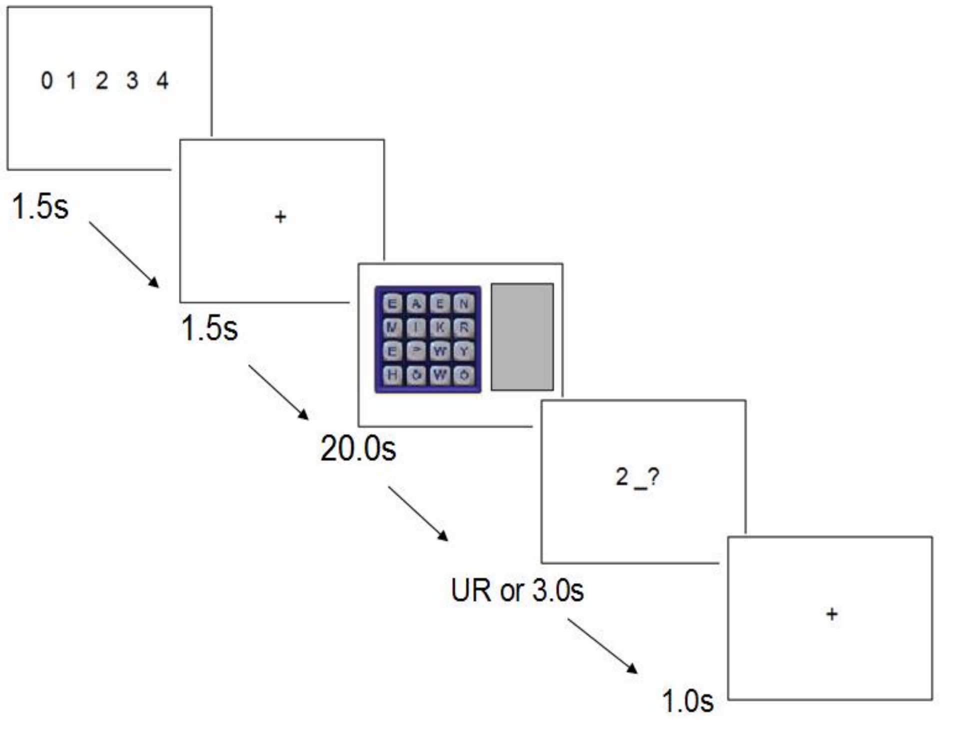

Figure 4.2. Example trial of the interleaved primary and secondary tasks (low load condition).

memory probe or when 3000ms had elapsed, there was a 1000 ms fixation pause at the end of each trial before the next trial started.

Following a practice tutorial, participants completed one baseline block (12 trials) under low working memory load followed by four fully counterbalanced experimental blocks (2 blocks per working memory load, each containing 16 trials). Sixty-Four, 4 x 4, letter matrices were generated for the total of 64 trials across the 4 main task blocks, with 16 letter matrices allocated to each block. The same set of 64 matrices were used for all participants and the same set of 16 letter matrices were allocated per block for all participants. However, these 16 matrices per block were randomly presented. Word game performance was calculated by using a points based allocation system (as described in the manipulation of achievement goal states section below) whereby 1 point for every correctly identified 3 letter word or for the first 3 letters of correctly identified words longer than 3 letters, and an additional 1 point for every letter after the third letter of correctly identified words longer than 3 letters were allocated[16]. The current thesis author independently identified words as correct or incorrect. The Oxford English dictionary was consulted in the event of a discrepency. Points were then summed for each letter matrix and these were then totalled per block. Total word game performance, for low and for high working memory load separately, were calculated by summing the total of the two block scores for each working memory load. All participants were informed that completion of the task (interleaved word game and load task) in its entirety was important.

Manipulation of Achievement Goal States

The dual-paradigm achievement goal task was performed under one of three experimental conditions: mastery- approach goal (MAG), performance-approach goal (PAG) or no-goal (NG). Goal states were manipulated via target-based instructions framed in terms of an explicit normative or self-referential goal, according to chapter 2 findings. However, as noted above, manipulations were designed to be more task and target specific relative to those used in the previous chapter study. In both the MAG and PAG conditions, participants were told prior to task engagement that they would receive points for words identified in the word game: 1 point for every 3 letter word or for the first 3 letters of words longer than 3 letters, and an additional 1 point for every letter after the third letter of words longer than 3 letters. Participants were also told that the computer would automatically calculate scores throughout the task

[16] Other scoring methods were tried, e.g., by summing the number of words correctly identified for each letter matrix which were then totalled per block, but this method produced identical results to the one described.

and points are only achieved for correctly identified words and would not be deducted for any errors made.

Following a baseline block, participants in the MAG condition read the following set of instructions:

"You have just completed round 1 of the task, press the space bar to calculate your score for this round"

"Your round 1 score is X points. Your aim for this task is to develop your skill at performing the word game well. Press the space bar to continue"

"As such your goal for round 2 is to do better than your total round 1 score, which means getting more than X points in round 2. The computer will tell you at the end of round 2 whether you achieved above your previous round score. Press the space bar to start round 2"

In contrast, following a baseline block those in the PAG condition read the following set of instructions:

"You have just completed round 1 of the task, press the space bar to continue"

"Your aim for this task is to demonstrate your skill at performing the word game well in comparison to other students who have taken part. The average total score of students who have taken part so far in round 2 is X points. Press the space bar to continue."

"Your goal for round 2 is to do better than this average student round 2 score, which means getting more than X points in round 2. The computer will tell you at the end of round 2 whether you achieved above the average student score for the round. Press the space bar to start round 2"

These instructions to either perform better than ones own previous round score or than a normative score (for MAG and PAG respectively) were then repeated between each of the remaining 3 experimental blocks (i.e., between block 2 and 3, 3 and 4, and, 4 and 5) with adjustments made to references to '*round X*' and '*X points*' accordingly. With the aim of 1) ensuring that only the framing of the target scores differed across goal conditions, 2) to prevent block by block feedback variability within and between conditions thus ensuring consistency in terms of approaching a positive improvement outcome focus, and 3) to prevent actual numerical targets becoming more salient than the actual framing/focus of the achievement goals, a standardised set of target scores, which increased across experimental blocks were presented for both goal state conditions[17]. That is, although the target scores were framed as either self-referential or normative for the MAG and PAG conditions respectively, the actual numerical target that these groups were presented with for each experimental block were exactly the same, and increased throughout blocks. Accordingly, all participants in the MAG and PAG conditions were provided with equivalent feedback at the end of each block (i.e., '*Yes, you scored better than your previous round score*' or ' *Yes, you scored better than the average student score for this round*'), presented in green font colour (all other instructions presented in black

[17] Average scores achieved by participants (n=10) during piloting on 4 task blocks based upon the exact same trial and block length set up as described in the current experiment 1 (under standard task instructions, no goal manipulations), were used as target scores for blocks in this current main experiment 1. Average scores from each of the 4 pilot blocks were calculated and then ranked in ascending order, resulting in increasing target scores as the task progressed. These were 88, 95, 105, and 116 across the respective experimental blocks 2, 3, 4, and 5.

font colour). Keeping feedback consistent between blocks and between conditions was also deemed important given that feelings of competence have been found to increase intrinsic motivation (Ryan, 1982). All task instructions, goal instructions and feedback was read by participants directly from a PC monitor. Participants in the NG condition received only standard task instructions, that is, no points system or target goals were provided[18].

Measures

Trait Goal Orientation. As described in the previous chapter, the approach scales from Elliot and Murayama's (2008) Revised Achievement Goals Questionnaire were used. (Mastery-approach; α = .67) (Performance-approach; α = .87).

Working Memory Capacity. As described in the previous chapter, the Operation Span (OSPAN) task (Turner & Engle, 1989) was used to measure working memory capacity (WMC).

Verbal Ability. Two tests were administered to measure participants verbal ability; The Wechsler Adult Intelligence Scale Revised (WAIS-R) vocabulary subset (Wechsler, 1981), and The Delis-Kaplan Executive Function System (D-KEFS) (Delis, Kaplan, & Kramer, 2001) letter fluency condition of the verbal fluency test. The WAIS-R vocabulary test presents a list of 35 words of increasing difficulty (e.g., fabric, ominous) and requires participants to supply word definitions. The test was administered according to the guidelines in the testing manual (Wechsler, 1981), with one exception whereby participants were asked to write their definitions down on a word list response sheet rather than provide definitions orally. Definitions were given a score of 0, 1, or 2 depending upon the degree of understanding expressed (e.g., 0 =

[18] Although those in the NG condition were not informed about any points or targets, their performance for the purpose of analyses, were still scored using the exact same method as those in the other two goal conditions.

wrong or vague response, 2 = a good synonym). Scores were summed to achieve a total vocabulary score and higher scores represented superior vocabulary with a maximum possible score of 70.

The Delis-Kaplan Executive Function System (D-KEFS) letter fluency condition of the verbal fluency test measures the ability to generate as many words as possible beginning with a specific letter in 60 seconds. The letters F, A and S were used, and words could not be the name of a person, place or a number. Word repetitions were excluded from scoring. A total fluency score was calculated by summing the number of words generated by the participant for all three letters.

State Anxiety. As described in the previous chapter, a 5-item measure drawn from Ryan, Koestner and Deci's Intrinsic Motivation Inventory (1991) was used to measure state anxiety with an internal consistency reliability of .86.

Manipulation Checks

Goal Recall: Task Purpose and Goal Assigned. As described in the previous chapter.

Goal State. As described in the previous chapter, state adapted forms of the mastery-approach and performance-approach scales from Horvath, Scheu and DeShon's (2001) Global Goal Orientation measure were utilised with internal consistency reliabilities of .85 and .92 respectively.

Goal Commitment. A five-item measure of goal commitment was also included in the current study to assess adherence to the target goals set within the MAG and PAG conditions. Items were taken from the Hollenbeck, Williams and Klein (1989) Goal Commitment scale (e.g., I was strongly committed to pursuing the goals assigned), and measured on a scale from 1 (*strongly disagree*) to 5 (*strongly* *agree*) with an internal consistency reliability of .82. Possible scores ranged from 5 to 25, with higher scores indicating stronger commitment to goals assigned.

Procedure

Participants were tested individually in a sound proof laboratory. Written consent was obtained and demographic and trait goal orientation items were completed first. Participants then completed the OSPAN, WAIS-R vocabulary and D-KEFS letter fluency assessments in a counterbalanced order, after which they were given a 5 minute break (but remained in the testing room) before being randomly assigned to the achievement goal conditions. After completing a practice tutorial followed by a baseline task block, goal states were then induced before completing the four main experimental blocks. All participants worked through the experimental blocks at their own pace by following on screen instructions. The experimenter remained in the testing room across all conditions, but sat quietly at the back of the room, out of participant sight. After completing the experimental blocks all participants completed (in counterbalanced order) the questionnaires assessing Goal Recall, Goal State, state anxiety and goal commitment. (Those in the control group did not complete the Goal Recall or goal commitment manipulation check.) Finally, all participants received a thorough debriefing on the purpose of the experiment and were thanked for their participation. This entire procedure lasted approximately 90 minutes.

Results

Manipulation Checks

Chi-square tests of independence confirmed that participants' post-task reported purpose, $\chi^2 = 35.28$, $df = 3$, $p < .001$, and assigned goal, $\chi^2 = 39.66$, $df = 3$, p

< .001, was consistent with their experimental condition. There were no significant differences in reported goal commitment between the participants in the MAG (M = 19.9, SD = 2.8) and PAG (M = 20.0, SD = 4.4) condition (p = .909), with both group commitment means indicating strong commitment to goals assigned. Goal State checks revealed significant differences in reported state mastery-approach, F(2,70) = 4.225, p = .019, and reported state performance-approach, F(2,70) = 4.610, p = .013, across groups. Participants in the MAG condition scored the highest in state mastery-approach (M = 14.96, SD = 2.85) in comparison to those in the PAG (M = 12.46, SD = 4.0), t(47)= 2.53, p = .015, and those in the NG control (M = 12.42, SD = 3.63) condition, t(47)= 2.74, p = .009. Participants in the PAG condition scored higher in state performance-approach (M = 13.08, SD = 5.15) than those in the MAG (M = 9.96, SD = 4.27), t(47)= 2.32, p = .025, and NG control (M = 9.42, SD = 4.10) condition, t(46)= 2.73, p = .009. Manipulation check results therefore clearly confirm effective inducement of goal states.

Preliminary Analyses

Descriptive statistics for all variables within each condition are presented in table 4.1. Correlations between key study variables are presented in table 4.2. No effect of gender, age or block load order on word game performance was found (*all p*'s > .70), and no group differences on word game points during the baseline block were identified, F < 1, *ns*, indicating that experimental groups did not significantly differ in terms of word game performance prior to goal inducement.

Table 4.1. Means and Standard Deviations for Study 3 Variables by Condition

	Mastery-Approach		Performance-Approach		No-Goal Control	
	M	*SD*	*M*	*SD*	*M*	*SD*
Trait Mastery-approach	12.52	2.04	12.43	2.15	12.05	1.87
Trait Performance-approach	11.17	3.31	10.19	3.28	9.74	2.66
State Mastery-Approach	14.96	2.85	12.46	4.00	12.42	3.63
State Performance-Approach	9.96	4.26	13.08	5.14	9.42	4.09
Vocabulary	49.13	10.25	46.86	10.08	48.64	14.07
Letter Fluency	55.71	16.64	56.09	15.76	53.52	12.67
Working Memory Capacity	19.79	9.85	20.22	11.26	17.74	8.43
State-Anxiety	16.58	7.24	18.92	7.24	20.83	6.8
Goal Commitment	19.92	2.81	20.04	4.42	-	-
Total Game Points (Low Load)	204.24	71.10	200.42	131.52	169.96	64.97
Total Game Points (High Load)	84.72	43.37	108.71	123.72	99.50	52.14
No. of 3 Letter Word Lengths Found (Low Load)	53.20	24.93	52.08	29.52	50.50	27.61
No. of 3 Letter Word Lengths Found (High Load)	25.32	18.91	31.91	28.34	33.95	25.37
No. of 4 Letter Word Lengths Found (Low Load)	57.16	21.46	52.45	39.00	45.62	22.67
No. of 4 Letter Word Lengths Found (High Load)	22.12	13.87	29.33	37.77	26.62	18.58

Note: Mastery-Approach, N= 25; Performance-Approach, N= 24; No-Goal Control, N= 24. State mastery-approach and state performance-approach are self-report forms. Those in the no-goal control condition didn't complete a goal commitment measure.

Table 4.2. Intercorrelations Among Key Study 3 Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Trait Mastery-approach	-														
2. Trait Performance-approach	.30*	-													
3. State Mastery-Approach	.06	.18	-												
4. State Performance-Approach	-.10	.20	.13	-											
5. Vocabulary	.09	-.04	.07	-.10	-										
6. Letter Fluency	.16	.20	.01	.19	.16	-									
7. Working Memory Capacity	.15	.17	-.14	.11	.32*	.24*	-								
8. State-Anxiety	.07	.10	-.04	.25*	-.21	.08	.03	-							
9. Goal Commitment	-.08	-.02	.21	.16	.12	.02	-.03	-.03	-						
10. Total Game Points (Low Load)	.11	.32**	-.04	.31**	.38**	.38**	.20	.04	.26	-					
11. Total Game Points (High Load)	.07	.27*	-.16	.27*	.30*	.36**	.31**	.11	.25	.81**	-				
12. No. of 3 Letter Word Lengths Found (Low Load)	.18	.23	-.10	.23*	.21	.12	.20	.01	.14	.39**	.41**	-			
13. No. of 3 Letter Word Lengths Found (High Load)	.04	.14	-.16	.22	.26*	.05	.17	-.05	.25	.37**	.61**	.75**	-		
14. No. of 4 Letter Word Lengths Found (Low Load)	.05	.28*	-.06	.25*	.33**	.35**	.19	.03	.23	.93**	.74**	.21	.27*	-	
15. No. of 4 Letter Word Lengths Found (High Load)	.06	.30*	-.17	.24*	.25*	.38**	.30*	.15	.21	.80**	.96**	.28*	.45**	.77*	-

*Note: *p<.05 **p<.01.* State mastery-approach and state performance-approach are the post-task self-reported forms.

Further analyses revealed that groups did not significantly differ on trait mastery-approach (p = .16), trait performance-approach (p = .38), working memory capacity (p = .66), vocabulary (p = .80), letter fluency (p = .83), or state-anxiety (p = .13). To assess whether these non-significant results were due to a lack of statistical power, a series of post hoc power analyses were conducted using GPower software (Faul, Erdfelder, Buchner, & Lang, 2009) with power (1 - β) set as 0.80. These revealed that total sample size would have to increase by between 25 to 240, in order for group differences to reach satistical significance at the .05 level. Thus there is some indication that these non-significant findings can be attributed to a limited sample size. Interestingly, trait performance-approach was found to positively correlate with total word game points under both low and high load.

For all participants, mean reaction times (RT, in milliseconds) to memory probes were significantly slower under high working memory load (M = 1639.37, SD = 267.61) than under low working memory load (M = 1073, SD = 156.85), $F(1,72)$ = 474.93, p < .001. Additionally, memory probe accuracy was higher with low working memory load (95%) than with high working memory load (57%), $F(1,72)$ = 237.24, p < .001. This indicates that the manipulation of working memory load was effective.

In further examining RT, a significant working memory load x goal group condition was found, $F(2,70)$ = 9.20, p < .001. No experimental group differences in mean RT to probes with low working memory were found (p = .67), however, under high working memory load groups significantly differed on correct probe RT, $F(2,70)$ = 4.53, p = .014. There were no significant differences in correct probe RT between the MAG and PAG conditions (p = .34), however, participants in the NG control (M = 1518.71, SD = 213.5) responded significantly faster to memory probes with high working memory load than those in both the MAG condition (M = 1661.24ms, SD = 266.870), $t(47)$= -2.06, p = .045, and PAG condition (M = 1737.24ms, SD = 280.32), $t(46)$= -3.038, p = .004. Similarly, there were no group differences in probe accuracy with low working memory load (p = .182), but however there were significant differences under high working memory load, $F(2,70)$ = 5.90, p = .004. The MAG and PAG condition did not differ in terms of probe accuracy (p = .528), suggesting there to be no differences in attentional bias towards this part of the task between achievement goal conditions. However, those in the NG control (*M* = 21.75, *SD* = 6.04) had a significantly higher probe accuracy under high load than those in the MAG (*M* = 15.64, *SD* = 6.82), $t(47)= 3.32$, $p = .002$, and PAG (*M* = 16.88, *SD* = 6.76) conditions, $t(46)= 2.63$, $p = .011$. Such differences between the NG control and both goal assigned states, potentially indicates that inducement into an achievement goal consumed some capacity that would have otherwise been devoted to the working memory task.

Experimental Task Performance

A 3 x 2 mixed ANOVA was conducted with goal group (MAG, PAG, NG) as the between-subjects factor, and working memory load (low and high) as the within-subjects factor. All performance analyses were restricted to trials in which a correct working memory probe response was made. There was no significant main effect of goal group, $F < 1$, *ns.* There was a significant main effect for working memory load, $F(1,70) = 248.443$, $p < .001$, with all participants performing significantly poorer under high working memory load than low load with estimated marginal means of 191.54 and 97.64 for low and high load respectively. Additionally, a significant working memory load x goal group interaction, $F(2,70) = 5.735$, $p = .005$, was found, indicating that the profile of word game performance across working memory load varied for the groups.

To follow this interaction up, a series of one-way within-subject ANOVAs revealed that participants in the MAG, $F(1,24) = 109.39$, $p < .001$, $\eta_p{}^2 = .820$, PAG, $F(1,23) = 72.98$, $p < .001$, $\eta_p{}^2 = .760$, and NG, $F(1,23) = 69.73$, $p < .001$, $\eta_p{}^2 = .752$, conditions all experienced a significant decline in word game performance from low to high working memory load, but that this effect was largest in the MAG condition and smallest in the NG control condition. As shown in figure 4.3, MAG and PAG participants are similar performers under low working memory load, but PAG participants appear to be better performers under high working memory load than MAG participants, suggesting that MAG pursuit is more influenced by working memory load, relative to PAG pursuit.

To further confirm this, a decrement score was calculated by subtracting each participants word game performance under high working memory load from their performance under low load providing a difference score in terms of performance

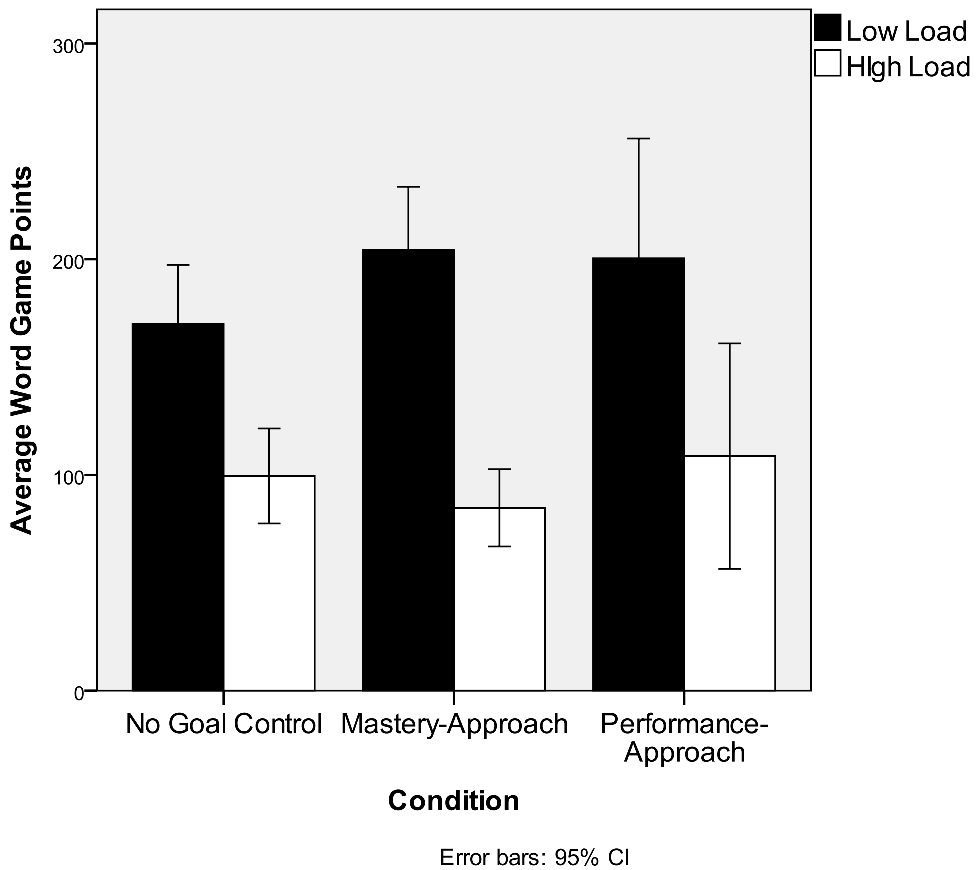

Figure 4.3. Average word game points under low and high load for each condition

decline from low to high load. Participants in the MAG condition suffered a larger decrement (*M* = 119.52, *SD* = 57.14) than those in the NG condition (*M* = 70.46, *SD* = 41.34), $t(47) = 3.43$, $p = .001$, and those in the PAG condition (*M* = 91.71, *SD* =

52.59), $t(47) = 1.77$, $p = .08$. The NG and PAG groups did not differ on decrement scores, $t(46) = -1.56$, $p = .13$. Interestingly the pattern of means presented in table 4.1 (also see figure 4.4), suggests that those in the MAG condition on average were finding the most 4 letter words under low load, but, the least number of 4 letter words under high load, suggesting those participants in this condition were unable to maintain their low load 4 letter word advantage under high load.

A potential strategy for performing well on this task would have been to attempt to reuse (re-find) previously formed words in new letter matrices presented.

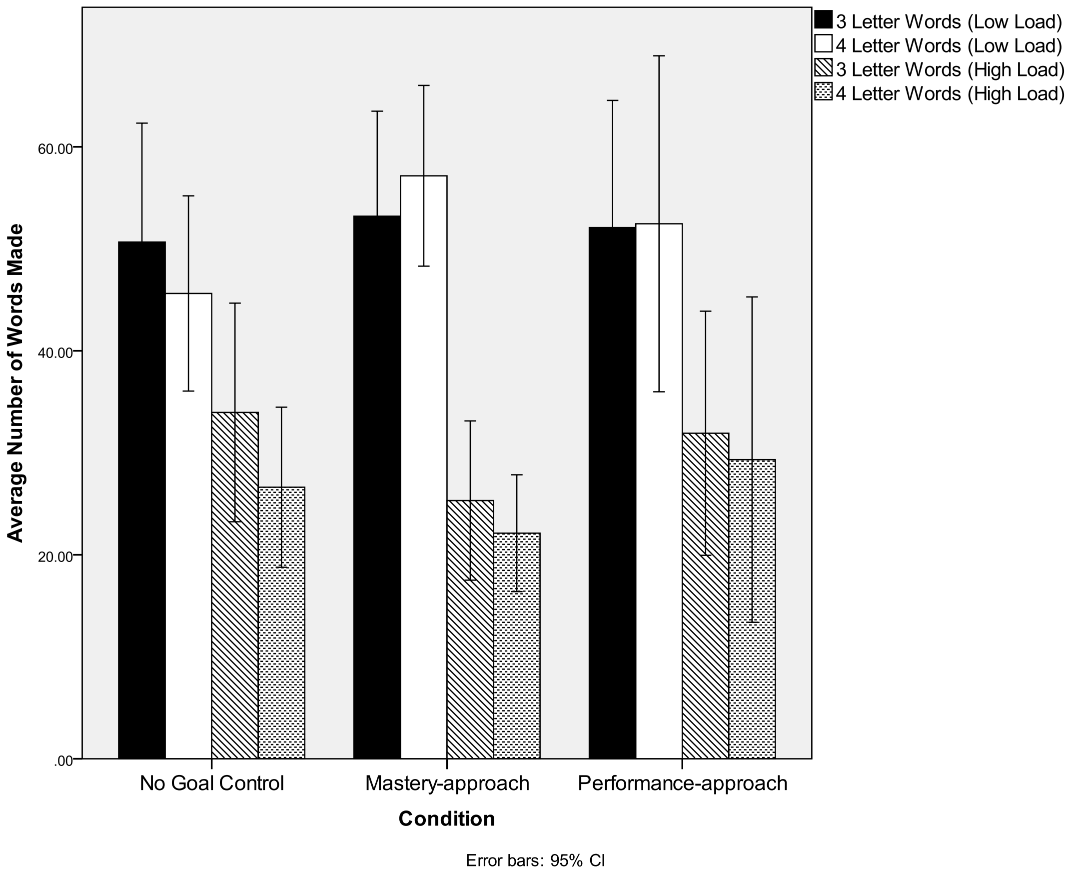

Figure 4.4. Average number of words made according to length under low and high load by experimental condition.

However, word repetition under both low and high load did not differ between experimental groups (p's > .48) . Finally, consistent with the previous chapter 3, no trait-state interactions were found.

Discussion

The present study examined the role of working memory in achievement goal pursuit by examining the influence of a secondary working memory task, varying in load, on a primary achievement goal pursuit task. Although all experimental groups experienced some primary task decline from low to high load (expected given the increased task difficulty that high load would present, and also representing some minimal demand on the same common pool of resources of the word game and load task), it was found that the most substantial word game performance decline from low to high secondary working memory load, was evident under pursuit of a mastery-approach goal, relative to a pursuit of a performance-approach goal and no-goal control. Assuming that poorer word game performance under high load, relative to low, is indicative of working memory engagement in the word game, these finding suggest that working memory plays a more vital role in the pursuit of a mastery-approach goal relative to a performance-approach goal. Post task manipulation checks all confirmed the effective inducement of desired motivational states, increasing confidence in attributing results to between state achievement goal group effects. Again, the present findings are highly unlikely to be confounded by differences in verbal ability, working memory capacity, state-anxiety or trait based achievement goal preferences. Present findings therefore fuel further confidence in the potential, differential, role of working memory in achievement goal pursuit. Findings will now be discussed and implications for the subsequent study in this thesis chapter will be considered.

Results clearly show that those pursuing a mastery-approach goal on a primary word game suffered the largest performance decline from low to high working memory load. Although those pursuing a performance-approach goal also suffered from some decline in word game performance from low to high load, this effect was smaller than those in the mastery-approach condition. This arguably suggests that pursuit of a mastery-approach goal relied more on working memory in order to perform the word game well, relative to performance-approach goal pursuit. Those assigned to the no-goal control condition demonstrated the smallest word game decline from low to high load. This implies that working memory resources were slightly more demanded by performance-approach goal pursuit relative to having no goal. It seems reasonable to infer that this could simply reflect the attentional consumption of 'goal assignment' relative to no goal assignment. Decrement score analyses confirmed this overall pattern of results, with those assigned a mastery-approach goal experiencing a significantly (although marginal in comparison to performance-approach) larger word game performance decrement from low to high load than those participants in the other conditions.

The pattern of mean word game points (as displayed in figure 4.3) suggest that participants in the mastery-approach and performance-approach conditions performed fairly similarly, and better than the no-goal controls, under low load. Importantly, this demonstrates that assignment of an achievement goal offered a task performance advantage over pursuit of no goal, consistent with some of the literature discussed in chapter 1 (Wegge, 2001; Wegge et al., 2001). Furthermore, the fact that those in the mastery-approach and performance-approach conditions were performing similarly under low load suggests that any possible differences in reliance upon working memory in order to perform the word game well was not reflected in overall word game points performance. It is possible that those in the performance-approach condition were performing as well as those in the mastery-approach condition, but simply through greater reliance upon less attention-consuming, 3 letter word formations. However, figure 4.4 clearly illustrates this not to be the case. It is also possible, when the overall pattern of performance decline results are considered, that those in the performance-approach condition were exploiting an automatic (e.g., implicit or 'insight based') approach to perform well under low load, rather than a more effortful strategy of incrementally constructing words. This may have allowed for equivalent primary task performance to mastery-approach pursuit under low load, but would be less susceptible to high load interference. A research study which addresses such possible working memory related, strategic task differences would be hugely beneficial to the current thesis aims.

A possible avenue for research development can be highlighted here based upon the previous point raised. Word game decline from low to high load has informed us that mastery-approach pursuit perhaps was relying more on working memory resources in order to perform well under low load, and that a smaller decline for performance-approach suggests this goal state was relying less on such resources to do well. However, it is possible that both goal states were similarly relying upon working memory resources to perform well under low load, and that high load just simply caused one goal state to change their resource dependent approach. Thus, an aim for the design of the next chapter study is to address this again using dual task methodology but employing a primary goal pursuit task that varies explicitly in terms of working memory demands. By doing so, more specific conclusions regarding any between goal group effects being specifically attributable to working memory demand/dependency differences can be reached.

In considering the present findings in light of results from chapter 3, although chapter 3 findings (N-Back) demonstrate an effect for performance-approach (poorer 3-Back performance relative to the other conditions), the present findings demonstrate an effect for mastery-approach (larger word game performance decline from low to high load relative to the other conditions). Given that current chapter results suggest mastery-approach pursuit engages working memory resources in order to do well, it is not surprising that participants in this goal state were able to better maintain 3-Back performance relative to performance-approach pursuit in chapter 3. Present findings therefore inform the understanding of the achievement goal-working memory relationship, particularly by demonstrating a relatively stronger reliance upon working memory resources for successful mastery-approach goal pursuit. Present findings therefore also offer some explanation for previous research within the literature that has found superior cognitive performance for a mastery-approach focus (Bereby-Meyer & Kaplan, 2005; Elliot et al., 1999; Escribe & Huet, 2005; Wolters, 2004), particularly in effortful conditions (Graham & Golan, 1991), if this goal focus is likely to call upon all available attentional resources on task. Additionally in considering the similarity of word game performance under low load, but diverging under high load between goal state groups, this pattern of task performance also appears consistent with the general literature that achievement goal differences typically emerge in more executively demanding situations (Barker et al., 2002; Graham & Golan, 1991; Murayama & Elliot, 2011; Wegge et al., 2001), as also demonstrated by chapter 3 findings.

Unlike chapter 3 findings, all manipulation checks significantly confirmed effective inducement of motivational states in the present study. Although it is not certain by any means, the use of more target specific based manipulations in the current study could have played a role here. In line with the previous chapter, the role of verbal ability, working memory capacity, trait goal orientation and state-anxiety accounting for results is unlikely. However, it is important to note that in the previous chapter 3 study and in the present study, state-anxiety was only measured post task completion and thus framed as experienced anxiety across both low and high working memory load collectively. Thus, understanding of the extent to which state-anxiety differed across loads for each experimental group is limited. The next chapter study would benefit from measuring state-anxiety under varying task loads, particularly to be more confident that any goal group performance effects between low and high load aren't attributable to possible changes in experienced anxiety under high load from low load. In addition to this point, it is necessary to draw attention to the fact that although in chapter 3 study participants were identified as high or low in terms of both working memory capacity and cognitive ability to ensure that pre-existing differences in these measures were not confounded with assignment to conditions, in the present study this was only repeated for capacity scores. Yet, on the basis that verbal ability was not found to differ across experimental groups, and that this variable similarly correlated with word game and probe performance for all experimental groups, there is still some encouragement that present findings go beyond that of differences in verbal ability.

Another key issue that should be addressed is task prioritisations. Given the design of the current study, participants pursuing either achievement goal were all told that points were specifically being awarded for performance on the word game, and as such standardised end of block feedback was based specifically on such word game performance. That is, it would have been clear to these participants that points, i.e., achievement of goals, was dependent upon word game performance rather than probe accuracy on the secondary working memory task. Although these achievement goal participants were informed during standard task instructions that completion of the task (interleaved word game and load task) in its entirety was important, it is possible that participants may have attempted to prioritise in some way by being biased towards the actual word game aspect of the task which awarded performance (and this may have differed between goal state conditions). Yet, on the basis that no differences in probe accuracy between the mastery-approach and performance-approach condition were found under low or high load, and that results are based upon analyses which were restricted to those trials in which correct probe responses were made, it is unlikely that any prioritisation differences between these two achievement goal groups influenced the pattern of results. Those participants in the no-goal control however achieved higher probe accuracy under high load than those in both the achievement goal states. Again, this is likely to reflect the more freed capacity that pursuit of no assigned goal would have allowed, relative to the burden of goal pursuit. These findings could be interpreted to represent prioritisation of the secondary working memory task relative to the word game on behalf of the controls (which would be more likely for the control condition on the basis that these participants were not informed about the points based element of the word game unlike the goal state conditions). Still, even though the no-goal control group had higher probe accuracy under high load (possibly increasing the opportunity for inclusion of word game points in analyses, or alternatively, increasing the chances of poorer word game performance if probe responses were taking priority), these participants were not according to points achieved, performing the word game at any significant advantage or disadvantage to either achievement goal group specifically under high load.

Overall, word game performance clearly suffers from low to high load for mastery-approach pursuit because the working memory resources that such goal pursuit essentially demands in order to do well on the word game is consumed. Whereas, word game performance appears to suffer less from low to high load for performance-approach pursuit. Although working memory resources *may* (implied by consistent low load task performance to that of mastery-approach pursuit) have been relied upon to perform the word game well under low load, it seems that when high secondary load consumes such resources, pursuit of a performance-approach goal prompts more maintained task performance. Of course, possible strategy-based explanations for this pattern of findings would be beneficial. Continued research within this thesis would clearly benefit from a task design which allows for more specific examination of working memory dependent strategies (or at least one which enables more working memory specific inferences to be made). Especially offering scope here, as previously noted in this discussion section, is a dual task design which employs a primary task known to vary in working memory intensity. If goal state reliance on working memory is related to primary performance, then the influence of secondary load will be more evident on parts of the primary task which depend more heavily on such resources. Addressing this in the next chapter study would shed more light on the present findings.

CHAPTER 5

Study 4

Overview of Chapter

The purpose of this study is to build upon the dual-task design of the study presented in chapter 4 by examining the role of working memory in achievement goal pursuit using a primary task known to vary in working memory intensity. If mastery-approach pursuit relies heavily on working memory (relative to performance-approach pursuit) then under low secondary load such goal pursuit should enhance performance on parts of a primary task which place heavy demands upon working memory. This advantage should then disappear under high secondary load. A second means of further investigating the link between achievement goal pursuit and working memory is to examine self-reported strategy use. If mastery-approach pursuit relies more on working memory intensive strategies than performance-approach pursuit, participants may be able to verbally report on such strategies, discussed in more detail below. Findings will be outlined and, again, discussed specifically in line with the implications for the design of the study to be presented in the next chapter (6).

Background Review

Findings from the previous chapter study clearly show that mastery-approach goal pursuit relies more strongly upon working memory than performance-approach goal pursuit. However, the lack of any task analysis of the primary task (a word game), and lack of any assessment of task strategies used by participants, made it difficult to confidently ascertain whether the difference in decline from low to high load reflected specific working memory reliance differences between goal groups. It is possible that high load simply promoted changes in response patterns for these goal groups, but both were similarly using working memory under low load. For example, were those in the performance-approach condition relying upon working memory whilst performing the word game under low load similarly to mastery-approach pursuit, but under high load simply adjusted their strategy? The primary aim of the current chapter study is to address these questions. Thus, by employing a primary goal pursuit task known to vary in working memory demand along with self-report assessment of task strategies, the current study aims to shed further light on the specific role of working memory in achievement goal pursuit. It aims to identify key differences in the working memory intensity of task strategies that mastery-approach and performance-approach pursuit might engage, and how such strategies are impacted by high load. Furthermore, by employing a similar dual-task design to that of chapter 4, but utilising a different task to induce goal pursuit, will make one even more confident that effects observed in the previous chapter results were not a feature of the actual word game task. By doing so, the current work will contribute much to the understanding of how being in a state of mastery-approach or performance-approach might differentially influence cognitive control, ultimately determining engagement with 'achievement' tasks.

A maths game is employed in the current study design as the primary goal pursuit task. Successful performance on more challenging mathematical based problem solving tasks is thought to heavily rely on working memory (Conway et al., 2005; DeStefano & LeFevre, 2004; Stevenson & Carlson, 2003). Research has clearly shown that if the capacity of working memory is consumed in some way, then such high-level maths based performance is likely to suffer (Beilock & Carr, 2005; Trbovich & LeFevre, 2003). Findings have indicated that the impact of high pressure situations on working memory availability often undermines maths performance, especially for those individuals who typically demonstrate superior maths performance (Ashcraft & Kirk, 2001). A particularly interesting area of research here is the 'choking under pressure' phenomenon. Researchers have illustrated that in working memory intensive tasks, particularly challenging maths based problem solving, manipulations which disrupt working memory interfere with performance by consuming (suggested to be because of heightened worries about the situation and consequences, i.e., heightened state anxiety) the resources that individuals need to perform well (Beilock, Kulp, Holt, & Carr, 2004; Beilock, Rydell, & McConnell, 2007; Cadinu, Maass, Rosabianca, & Kiesner, 2005). However, it has been further found that choking because of heightened pressure/anxiety varies as a function of individual differences in working memory capacity. Beilock and Carr (2005) got individuals both low and high in working memory capacity to perform a maths problem solving task which varied in working memory intensity under both a low-pressure and high-pressure manipulation (with the high-pressure manipulation known to disrupt working memory resources). It was found that those who invest more working memory suffered more under the manipulation known to disrupt working memory resources, and interestingly, that this decrement was limited to the maths problems with the highest demands on capacity (Beilock & Carr, 2005).

Importantly, these findings suggest that manipulations which consume working memory disrupt the performance of those individuals who actually rely more on working memory for superior performance. In fact, Beilock and Carr (2005) found that the maths based performance of those with limited working memory capacity didn't suffer under manipulations which consume working memory resources. Others have found very similar results with performance decrements of those with more available working memory being limited to problems which place the greatest demands on working memory (Gimmig, Huguet, Caverni, & Cury, 2006). This clearly illustrates that load taxes the resources that those with more working memory resources rely upon for successful task performance. This is clearly consistent with research demonstrating that under single-task conditions, those with more available working memory capacity outperform those with less capacity, however, addition of a secondary task causes those with more capacity to perform similarly to those with lower capacity by denying them the resources that they would normally rely upon to perform more superiorly on challenging tasks (Kane & Engle, 2000; 2002). Furthermore, this is consistent with the Distraction hypothesis (Wine, 1971) which proposes that pressure (load) leads to a decrease in the availability of working memory resources which in turn has a negative impact upon the performance of cognitively demanding tasks.

To investigate possible strategy-related explanations behind findings relating to maths problem solving, Beilock and DeCaro (2007) turned to the dual-process theory literature. According to this literature, two distinct processes support performance in problem solving related tasks, that of associative and rule-based (Evans, 2003; Sloman, 1996; Stanovich & West, 2000). Associative strategies involve reliance on implicit processes believed to operate spontaneously, thus making little demand on working memory (Logan, 1988; Rydell, McConnell, Mackie, & Strain, 2006). In contrast, rule-based strategies involve reliance upon explicit knowledge in order to reach solutions, thus placing much heavier demands on working memory (Stevenson & Carlson, 2003). Rule-based strategies therefore involve operations on mental representations, i.e. the involvement of working memory, whereas, an associative strategy is more independent of working memory. Relating this specifically to maths based problem solving, Siegler (1988a, 1988b) outline that representations of maths based problems are stored in an associative network linking possible answers to problems (e.g., 25 - 5). Accordingly, those who tend to employ more resources in order to execute computations, tend to work to higher thresholds for retrieval of such information about maths problems from this associative network. In other words, they tend to rely upon rule-based strategieses (Siegler, 1988a). However in contrast, when there are less resources available then there is an increased chance that associatively sourced solutions will prevail.

On the basis of this, Beilock and DeCaro (2007), consistent with other research findings (De Neys, 2006; Evans, 2003), suggest that the amount of working memory 'brought to the table' for task execution, would influence the process (either associative or rule-based) that is more readily used. That is, if more working memory resources are available then rule-based computations would be more likely in solving maths problems, however, limited engagement of resources would make one more prone to rely on associative processes which make fewer demands on working memory (Beilock & DeCaro, 2007). In addressing these propositions, Beilock and colleagues particularly relied upon Guass Modular Arithmetic Task (see Bogomolny, 1996) (full task description in the method section of the current chapter study) which involves making true/false judgments about problem equations (on this occasion, with all problems equated on working memory demand). This task is based upon common maths operations (e.g., addition and division) that fundamentally require the use of multistep problem solving algorithms, although associative based 'shortcut' strategies can also assist performance. Beilock and DeCaro (2007) got participants to perform the maths task under either a manipulation known to load working memory or one known to make little demand, and to report their problem-solving strategies after completing the task for a subset of problems solved. Findings showed that differences in the amount of available working memory resources influenced the strategic approaches to solving the maths problems. Specifically, those with more available resources were more likely to be relying on rule-based processing under low demand, but under a manipulation loading resources these individuals responded by using simpler (more associatively driven), although less accurate, strategies (Beilock & DeCaro, 2007). Thus changes in load evidently altered strategy use. Under both low and high load, those with less working memory resources evidently opted for more associative strategies (Beilock & DeCaro, 2007). Researchers within this area have also shown that when simpler strategies are actually more optimal, those with less working memory resources are more likely to demonstrate better performance through identification of the optimal simple strategy relative to those with more available resources (Beilock & DeCaro, 2007). Findings clearly show that the availability of working memory influences individual task engagement.

In considering the combined ideas of the work of Beilock and colleagues presented, the current study intends to employ a similar design but focuses on state based manipulations of achievement goals rather than individual differences in working memory. Previous study findings in this current thesis had clarified possible variations in working memory reliance between mastery-approach and performance-approach goal pursuit, however, it is still unclear exactly why group differences emerge under high load. First, the current use of a primary task which varies in working memory intensity, and second, measurement of self-report strategy use specifically pertaining to more or less working memory intensive strategies, will help provide some clarity here. If mastery-approach pursuit relies more on working memory (relative to performance-approach), as findings from chapter 4 suggest, then we expect to observe the use of rule based task strategies by participants inducted into a mastery approach state. The use of such a strategy should facilitate performance on challenging parts of a task that demand working memory. However, in the presence of high secondary load this advantage would be expected to disappear, with load consuming resources necessary for a rule based strategy. Conversely, if performance-approach pursuit relies less on working memory, then this state should more readily engage associative strategies. Reliance on associative strategies would limit performance on challenging parts of a task which demand working memory (on the basis that associativley derived answers don't permit as superior accuracy as explicit strategies), but would reduce susceptibility to experiencing a decline in performance under high load.

In sum, it is predicted that a) mastery-approach pursuit will more readily engage the use of rule based strategies, whereas, performance-approach will more readily engage the use of associative strategies, b) such differential engagement will particularly exert an effect on challenging (high working memory demand) parts of an achievement task, and c) on such challenging parts, the presence of high secondary load will be particularly damaging for the goal state which engages rule based strategies (i.e., mastery-approach) by consuming the resources necessary for such strategy use.

Method

Participants

Eighty University of London undergraduates (57 female), recruited via a psychology research participation scheme, took part in the current research for course credits. Age was recorded in the same ranges as in chapters 3 and 4, with a modal range of 18-25 years accounting for 90% of the sample. All participants had normal or corrected to normal vision. Informed consent was obtained prior to participation.

Experimental Task

Consistent with the design of the chapter 4 study, participants performed an achievement goal pursuit task under dual-task conditions that the author programmed using e-prime software (Schneider et al, 2002). The goal pursuit task was that of Gauss's (1801) Modular Arithmetic task (Bogomolny, 1996), in which participants are presented with a problem statement (e.g., "6 = 3 (mod 2)"), and are required to make a true or false judgment on this problem within 20 seconds[19]. Problem statements[20] are presented centered on a 15" PC monitor in black Arial font size 48 on a white background. The problem statements are solved by subtracting the middle number from the first (e.g., 6 – 3) and then dividing the result of this subtraction by the *mod* number (e.g., 3÷2). If this division results in a whole number the participant is required, using a QWERTY keyboard, to make a true response (Z key), if the result is not a whole number then a false response (M key) is required. Problem statements remained on screen until a response was made or until 20 seconds had elapsed. First and middle numbers of the problem statements were sourced from a range of 2 to 63, and *mod* numbers from a range of 3 to 9. Problem statements were manipulated to be either low or high in working memory demand. Those high in demand, relative to low demand, were determined by whether the first step of the problem statement had a number larger than 20 or required a borrow operation[21], which would arguably require maintenance of more information placing more demand on working memory (Beilock & Carr, 2005; Ashcraft & Kirk, 2001). This particular task was also selected on the

[19] This 20 second response period was determined based upon average RT published in previous research (Beilock & Carr, 2005) in conjunction with average RT analyses from piloting of the problem statements.

[20] The exact set of problem statements used and presented by Beilock and Carr (2005) were used in the current study.

[21] Borrowing operations were those which when subtracting, a participant had to take a unit from the next larger denomination in the minuend so as to make a number larger than the number to be subtracted.

basis that, although rule-based, step-by-step algorithms of working the problem statements out produced the most superior performance, associative based short cut strategies could also be used to reach a correct answer (not on all occasions) without requiring a working memory intensive multistep problem solving algorithm. For example (in accordance with the reports of Beilock & DeCaro, 2007), it is possible to conclude that problem statements with even numbers are more likely to be true because even numbers are associated less often with remainders in division, and thus responding true to those problems with even numbers will likely produce a correct answer (although not all of the time). This more associative strategy clearly cuts out the need to engage working memory resources so readily, but is prone to error. The exact strategy categories examined in the current study will be outlined in the results section of this chapter.

As per the previous chapter study, the problem statement task was interleaved with a successor naming working memory task, however, given the number based focus of the primary problem statement task, letters rather than digits were used. See figure 5.1. Specifically at the start of each trial, in the condition of low working memory load a memory set was always presented in fixed order consisting of the letters A, B, C, D, E. However, in the high working memory load condition the letters X, Q, L, F, J were used with the letter X always remaining in the first position of the set but the order of the letters Q, L, F, J was varied at random. Correspondingly, memory probes presented were equally likely to be A, B, C, or D in the low load condition and any of the letters X, Q, L, F, J in the high load. Participants responded using the keys 1-4 on a QWERTY keyboard for responses B-E respectively in the low load condition and using the keys S, D, F, G for responses Q, L, F, J respectively in the high load condition, all labelled accordingly. All other aspects of the working

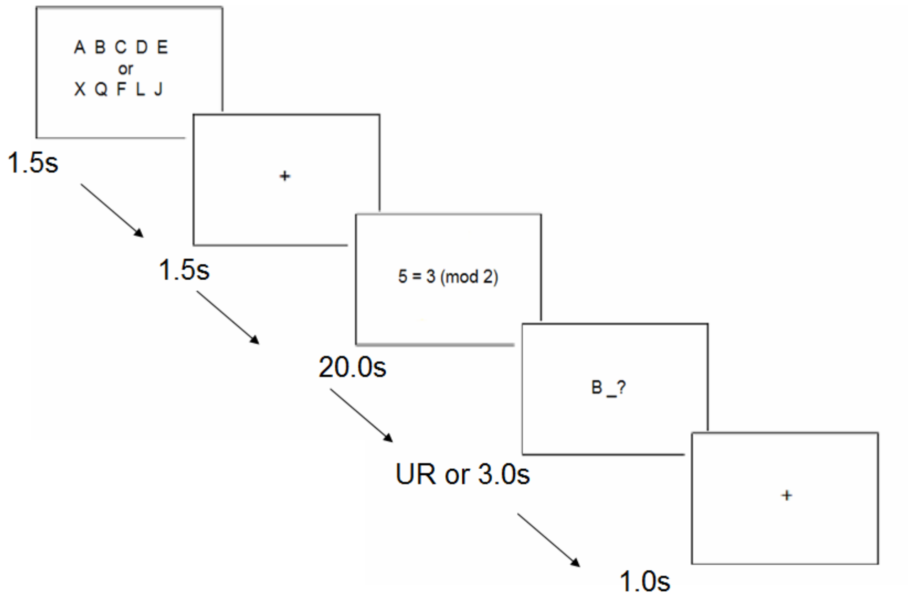

Figure 5.1. Example trial illustrating possible low and high load memory sets (with probe presented specifically relevant to low load set) and low demand modular arithmetic problem.

memory task interleaved with the problem statement task were as described in chapter 4.

Following a practice tutorial, participants completed a baseline block of eight problem statements under low working memory load (4 low demand and 4 high demand, randomly presented) followed by two counterbalanced experimental blocks (1 block per working memory load). The two main experimental blocks contained 24 trials each, for which a set of 24 problem statements were generated for each block, each containing 12 low demand and 12 high demand problem statements, presented in a different random order for each participant. Half of the problem statements in each main block required a ‘true’ response. No trial based feedback on response accuracy was provided. Problem statement performance was calculated by summing the number of correct responses to statements for each block.

Manipulation of Achievement Goal States

The same method of manipulation as described in the previous chapter study was used in the present study, however an *increasing* points based system was used. Participants were told that they would receive points for correct responses to the problem statements, specifically, 3 points for the first correct response made, 4 points for the second and 5 points for the third consecutive correct response made, and so on. However, as soon as an incorrect response was made, participants kept their total points achieved at that moment but had to start back at 3 points again for the next correct response[22]. This system was implemented as it was deemed that, given that points were being achieved from single responses (true or false response), a more complex system would deter participants from attempting to, even approximately, work out their own score. This was important for ensuring believability of the feedback provided, which will be shortly described.

Following a baseline block, participants in the MAG condition read the following set of instructions prior to starting the first of two experimental blocks:

"You have just completed round 1 of the task, press the space bar to calculate your score for this round"

"Your round 1 score is X points. Your aim for this task is to develop your skill at performing the problem statements well. Press the space bar to continue"

"As such your goal for round 2 is to do better than your total round 1 score, which means getting more than X points in round 2. Round 2 will be more than twice as long

[22] It was made very clear that points were not deducted for incorrect response, but that when an incorrect response was made you started back at the start of the 'points chain', whilst also keeping what points you had already achieved up to that moment.

as round 1, so your score will be adjusted accordingly at the end of the round to make for a fair comparison to the previous round score. The computer will tell you at the end of round 2 whether you achieved above your previous round score. Press the space bar to start round 2"

In contrast, following a baseline block those in the PAG condition read the following set of instructions prior to starting the first of two main experimental blocks:

"You have just completed round 1 of the task, press the space bar to continue"

"Your aim for this task is to demonstrate your skill at performing the problem statements well in comparison to other students who have taken part. The average total score of students who have taken part so far in round 2 is X points. Press the space bar to continue."

"Your goal for round 2 is to do better than this average student round 2 score, which means getting more than X points in round 2. For your information, round 2 will be longer than the round you just completed. The computer will tell you at the end of round 2 whether you achieved above the average student score for the round. Press the space bar to start round 2"

Goal instructions were then repeated once more between the first and second (also last) main experimental block with all reference to block length as shown in the instructions above, removed. For the same reasons as outlined in chapter 4, both goal conditions received a standardised set of increasing target scores, and accordingly, were told that they had reached their assigned goal for each main block[23]. All task, goal and feedback instructions were read by participants directly from a PC monitor. Participants in the NG condition received only standard task instructions, no points system or target goals were provided for such control participants.

Measures

Trait Goal Orientation. As described in chapter 3, the mastery-approach (α =.77) and performance-approach (α = .86) scales from Elliot and Murayama's (2008) Revised Achievement Goals Questionnaire were used.

Working Memory Capacity. As described in the previous chapter, the Operation Span (OSPAN) task (Turner & Engle, 1989) was used to measure working memory capacity.

Arithmetic Ability. The Wechsler Adult Intelligence Scale Revised (WAIS-R) arithmetic subset (Wechsler, 1981) was used to measure pre-existing differences in arithmetic ability. A series of 16 arithmetic word problems (specifically problems 5 to 20 of the original subset excluding problems1 to 4) of increasing difficulty, each requiring an answer within time limits ranging from 15 to 120 seconds, were presented on a written question sheet to be solved without the use of paper or pencils to calculate answers. Participants were provided with a response sheet which consisted of a list of numbers 1 to 16 representing each arithmetic word problem and informed at the start that they were required to write their responses to each problem down next to the corresponding problem number, prompted by the experimenter

[23] Points that would have been achieved by participants (n = 7) during piloting, according to the 'bogus' point chain system for two pilot blocks based upon the exact same trial and block set as described in the current experiment 2 (under standard task instructions, no goal manipulations), were calculated and used as the target scores for both current main experimental blocks. Average scores calculated were ranked in ascending order, resulting in an increase in target score between the two main experimental blocks. These were 145 and 158 points.

according to the time limits for each problem. Timing begun immediately after each problem was read. The exact time taken to respond to each problem was recorded. Correct responses to problems 1 to 14 were scored with 1 point, and problems 15 and 16 with a maximum of 2 points depending on speed of response (with 2 points awarded for responses in under 10 seconds), resulting in a possible total score of 18 points .

State Anxiety. State anxiety was again assessed in order to account for any negative affective consequences of task demands and/or experimental manipulations. However, on this occasion the state form of the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, & Lushene, 1970) was used to assess experiences of anxiety during task performance in order to separately assess anxiety under low and high load task conditions. This scale (α = .88; an average reliability taken from scores across the two reporting occasions) consists of 20 statements (e.g., ‘I feel calm’ and ‘I feel nervous’) all starting with ‘*I feel*’ and completed with a one word anxiety related feeling. Participants were required to respond on a scale ranging from 1 (not at all) to 4 (very much).

Strategy Use. In order to assess any possible differences in participants strategies to solving the problem statements, i.e., as means of determining whether participants were following a multi-step strategy to solving the problem statements or not, we presented participants with the following question on a piece of A4 paper at the end of the first and the second (last) task block (as per Beilock & DeCaro, 2007); *‘Can you write in the space provided how you mostly solved the challenging problem statements in the last round’.*

Manipulation Checks

The same manipulation check measures as described in chapter 3 and used in chapter 4 study were employed to assess *task purpose, goal assigned, goal state* and *goal commitment*. All references in the phrases of the task purpose check list were to ‘the problem statement game’. The mastery-approach and performance-approach scales of the Horvath et al. (2001) motivational state scale achieved internal consistency reliabilities of .88 and .90 respectively. Additionally, the Hollenbeck et al. (1989) goal commitment scale had an internal consistency reliability of .80.

Procedure

Participants were tested in the same sound proof laboratory as used in the studies presented in chapters 3 and 4. The same procedure as described in the previous chapter 4 study was followed with the following exceptions: After completing a practice tutorial followed by a baseline block, goal states were then induced before completing two main experimental blocks. Across all conditions, between the first and second main experimental block participants completed the strategy use question and the STAI measure and then completed both of these again at the end of the second (also last) experimental block. This provided a state-anxiety assessment for both main blocks of the task (i.e., a state-anxiety score for each working memory load), rather than an overall post-task assessment. This also allowed for strategy reliance to be measured under low and high secondary load. Following this second STAI measure, participants completed the manipulation check measures in counterbalanced order, finally followed by the strategy use questions. Testing sessions lasted approximately 75 minutes.

Results

Manipulation Checks

Task purpose, $\chi^2 = 29.05$, $df = 3$, $p < .001$, and goal assigned, $\chi^2 = 41.76$, $df = 3$, $p < .001$, checks confirmed that MAG and PAG participants correctly identified their goal state condition, and no differences in goal commitment between these conditions was found, $t(52) = .891$, $p = .377$, with both MAG ($M = 21.85$, $SD = 3.25$) and PAG ($M = 21.18$, $SD = 2.19$) participants reporting strong commitment to goals assigned. Significant group differences for Goal State checks on mastery-approach, $F(2,77) = 6.438$, $p = .003$, and performance-approach, $F(2,77) = 10.693$, $p < .001$, scales, also revealed that those in the MAG ($M = 15.15$, $SD = 3.790$) condition scored higher in state mastery-approach than those in the PAG ($M = 12.82$, $SD = 4.01$), $t(53) = 2.21$, $p = .031$, or NG ($M = 11.44$, $SD = 3.49$), $t(50) = 3.66$, $p = .001$, and that those in the PAG ($M = 14.57$, $SD = 3.54$) scored higher in state performance-approach than those in the MAG ($M = 9.96$, $SD = 4.69$), $t(53) = 4.12$, $p < .001$, and NG ($M = 10.60$, $SD = 3.66$), $t(51) = 4.01$, $p < .001$. Thus, manipulation appears to have been effective.

Preliminary Analyses

Descriptive statistics are presented in table 5.1. Correlations between key study variables are presented in table 5.2. Gender, age and the order in which participants completed the low and high working memory experimental blocks, for both low and high demand problem statements, had no effect on problem statement performance (*all* p's > .30). No group differences on baseline problem statement performance was found for either low demand problems, $F(2,77) = 1.12$, $p = .33$, or high demand problems, $F(2,77) = 2.30$, $p = .11$. No significant group differences on

Table 5.1. Means and Standard Deviations for Study 4 Variables by Condition

	Mastery-Approach		Performance-Approach		No-Goal Control	
	M	*SD*	*M*	*SD*	*M*	*SD*
Trait Mastery-approach	12.83	2.14	12.95	1.93	13.06	1.47
Trait Performance-approach	12.09	2.71	11.95	2.40	11.18	2.15
State Mastery-Approach	15.15	3.79	12.82	4.01	11.44	3.48
State Performance-Approach	9.96	4.68	14.57	3.54	10.60	3.66
Arithmetic Ability	11.44	2.37	11.82	2.53	12.48	2.29
Working Memory Capacity	17.74	9.28	17.00	9.25	17.76	8.50
State-Anxiety (low load)	34.52	9.03	31.86	7.84	32.44	8.19
State-Anxiety (high load)	42.56	8.38	39.79	8.54	40.04	9.27
Goal Commitment	21.85	3.24	21.18	2.19	-	-
Low Demand Problem Accuracy (low load)	11.26	1.40	11.32	1.30	11.36	.86
High Demand Problem Accuracy (low load)	9.30	2.55	7.96	3.20	9.00	2.84
Low Demand Problem Accuracy (high load)	7.59	3.34	7.64	2.85	7.76	2.26
High Demand Problem Accuracy (high load)	4.37	2.57	5.54	2.42	4.60	2.21

Note: Mastery-Approach, N= 27; Performance-Approach, N= 28; No-Goal Control, N= 25. State mastery-approach and state performance-approach are self-report forms. Those in the no-goal control condition didn't complete a goal commitment measure.

Table 5.2. Intercorrelations Among Key Study 4 Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Trait Mastery-approach	-												
2. Trait Performance-approach	.33**	-											
3. State Mastery-Approach	.26*	-.08	-										
4. State Performance-Approach	.16	.14	.04	-									
5. Arithmetic Ability	.02	-.09	-.15	.77	-								
6. Working Memory Capacity	-.03	.02	-.03	-.04	.11	-							
7. State-Anxiety (low load)	-.15	.22	-.04	.09	-.20	.10	-						
8. State-Anxiety (high load)	-.12	.10	.02	.05	.01	.12	.57**	-					
9. Goal Commitment	.04	.02	.25	-.03	.28*	-.01	-.01	.10	-				
10.Low Demand Problem Accuracy (low load)	.02	-.13	-.04	.11	.26*	-.15	-.17	.11	.01	-			
11. High Demand Problem Accuracy (low load)	.09	-.16	.18	.03	.40**	.06	-.19	.04	.25*	.16	-		
12. Low Demand Problem Accuracy (high load)	.20	.30*	-.05	.19	.27*	.24*	-.04	-.07	.08	.31**	.04	-	
13. High Demand Problem Accuracy (high load)	.03	.01	-.09	.23*	.38**	.17	.09	.02	.14	.12	.07	.35**	-

*Note: *p<.05 **p<.01.* State mastery-approach and state performance-approach are the post-task self-reported forms.

trait mastery-approach (p = .51) or trait performance-approach (p = .74), working memory capacity (p = .94), or WAIS-R arithmetic (p = .30) were found. To assess whether these non-significant results were due to a lack of statistical power, a series of post hoc power analyses were conducted using GPower software (Faul, et al., 2009) with power (1 - β) set as 0.80. These revealed that total sample size would have to increase by between 65 to 1122, in order for group differences to reach satistical significance at the .05 level.

All participants self-reported state-anxiety was heightened under high working memory load (M = 40.80, SD = 8.71) relative to low load (M = 32.94, SD = 8.35), $t(79)$= 8.91, p < .001. However, groups didn't significantly differ in such reported state-anxiety under low memory load, $F(2,77)$ = .76, p = .47, or under high working memory load, $F(2,77)$ = .83, p = .44. Thus it would be difficult to explain any possible between group differences within the current work in terms of anxiety.

For all participants and regardless of problem statement demand, memory probe responses were significantly longer under high working memory load (RT: M = 1177.38ms, SD = 344.86), $F(1,79)$ = 10.06, p = .002, and less accurate (52%), $F(1,79)$ = 119.40, p < .001, than those under low working memory load (RT: M = 1031.27ms, SD = 187.20) (Accuracy: 85%), suggesting the manipulation of working memory load was effective. Furthermore, participant responses to high demand problem statements, regardless of working memory load condition, were significantly slower (RT: M = 8271.02ms, SD = 2487.72), $F(1,79)$ = 351.68, p < .001, and less accurate (36%), $F(1,79)$ = 126.47, p < .001, than those to low demand problem statements (RT: M = 4136.76ms, SD = 1285.51) (Accuracy: 47.2%), indicating that the manipulation of problem statement working memory demand was effective. In further examining RT, no significant interaction between working memory load x achievement goal group was found, $F(2,77)$ = 1.82, p = .169. Mean RT to probes under low working memory load, $F(2,77)$ = .256, p = .77, and under high working memory load, $F(2,77)$ = .640, p = .530, were not found to differ between groups. Similarly, no group differences in probe accuracy under low working memory load, $F(2,77)$ = 1.37, p = .26, or high load, $F(2,77)$ = .555, p = .58, were found.

Accuracy Analyses

Problem statement performance was examined in a 2 (Working memory load: low, high) x 2 (Problem Statement Demand: low, high) x 3 (Achievement Goal Condition; MAG, PAG, NG), ANOVA. All analyses were restricted to trials in which a correct probe response was made. A significant main effect for working memory load, $F(1,77) = 185.28$, $p < .001$, $\eta p^2 = .706$, indicated that all participants performed poorer under high working memory load than low load, regardless of problem statement demand. Also, a significant main effect for problem statement demand was confirmed, $F(1,77) = 115.85$, $p < .001$, $\eta p^2 = .601$, with all participants having lower accuracy on high demand problems regardless of secondary load.

A significant three-way interaction was also obtained, $F(2,77) = 3.18$, $p = .047$, $\eta p^2 = .076$. This reflected a significant 2 (working memory load: low, high) x 3 (Achievement Goal Condition; MAG, PAG, NG) interaction for high demand problem statements, $F(2,77) = 3.81$, $p = .026$, $\eta p^2 = .090$, but not low demand problem statements, $F(2,77) = .006$, $p = .994$, $\eta p^2 < .001$, suggesting that the impact of working memory load on performance of high demand problem statements differed across goal groups. Further analysis confirmed that participants in all conditions experienced a significant decline on high demand problem accuracy from low to high load (MAG, $F(1,26) = 89.72$, $p < .001$, $\eta p^2 = .775$, PAG, $F(1,27) = 8.60$, $p = .007$, $\eta p^2 = .241$, NG, $F(1,24) = 45.73$, $p < .001$, $\eta p^2 = .656$), but that this effect was largest in the MAG condition and smallest in the PAG condition. As shown in Figure 5.2, MAG participants appear to be the most superior high demand problem statement performers under low working memory load, but, become the weakest high demand problem statement performers under high working memory load. Results suggest that PAG participants depend less on working memory relative to MAG and NG.

Analyses of the high demand problem statement decrement scores from low to high working memory load, showed that scores of those in the mastery-approach condition (M = 4.93, SD = 2.70) were significantly greater than decrement scores for those in the performance-approach condition (M = 2.43, SD = 4.38), $t(53)$ = 2.53, p = .014, and were near-significantly larger than decrement scores for those in the NG condition (M = 4.40, SD = 3.25), p = .072.

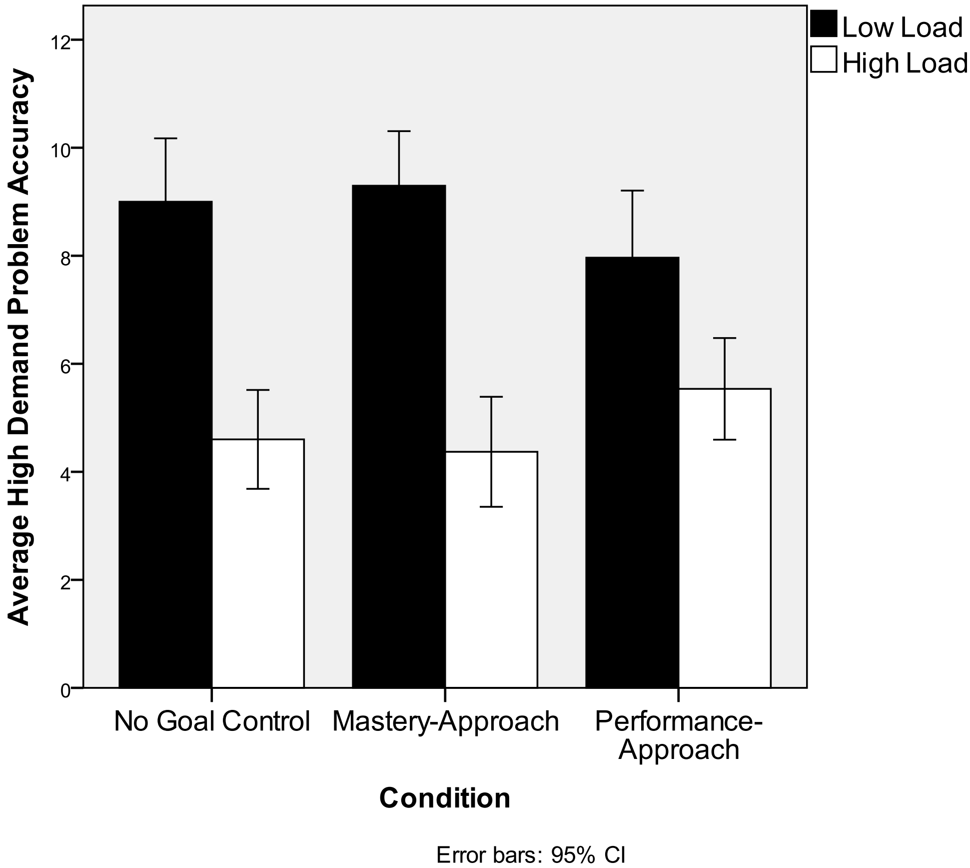

Figure 5.2. Average high demand problem statement accuracy under low and high load by condition.

Regression analyses were run to assess possible trait-state achievement goal interactions. The interaction term between trait and state achievement goal didn't explain a significant difference in problem statement accuracy (p > .05).

Task Strategies

Strategies were coded independently by the current thesis author. The strategies reported by participants were specifically examined under low and high secondary load, and classified into one of the following three categorises (again, in accordance with the work of Beilock & DeCaro, 2007). Firstly, a working memory intensive rule based strategy, i.e., reports of adhering to an incremental, step-by-step strategy, for example, "*I assumed the equals sign was a minus sign and subtracted the second number from the first in my head and then worked out how many times the number at the end went into that answer*". The second category was if estimation was evident based on associations, i.e., associative strategies which cut out a step-by-step, working memory intensive strategy, for example, *"I was mostly rounding the numbers and roughly deciding if it was right or not.*", and "*All the numbers together just looked liked it would be true because sometimes it was clear that the mod number would fit exactly*". The third category was used to represent those strategies which didn't make sense or lacked enough detail to make a decision with regards to membership in the previous categorises. On the basis that participants were specifically asked to report on *the* mostly used strategy to solving the challenging problem statements, the majority accordingly reported one identifiably clear response to this strategy question. However multiple responses were evident for five participants. For two of these participants, responses were all still evidently within the same category and so their overall response was coded by that one category. Those three participants who appeared to report a mixture of both category 1 and category 2 strategies, were assigned to category 3 as it was inappropriate to make a decision regarding priority to either of the previous categorises.

Table 5.3 depicts the percentage of participants who reported using each strategy under low load and under high load by experimental condition. It was important to illustrate that rule-based strategies better predict superior performance on high demand problem statements, under low secondary load at least, and to examine which strategy predicted, if any, more superior performance on high demand problem statements under high secondary load. According to propositions outlined at the start of this current chapter, rule-based strategies should be less likely to predict superior high demand problem statement accuracy under high secondary load due to the limited availability of resources that such a strategy would require. A significant interaction between working memory load x strategy use was found, $F(2,72) = 7.4$, $p = .001$. Firstly, high demand problem statement accuracy under low load was regressed on reported strategy use (dummy coded[24]). A significant model was found, $F(2,79) = 18.94$, $p < .001$, with rule-based strategies significantly predicting accuracy ($\beta = .775$, $p < .001$), and associatively driven strategies also predicted accuracy but was not as strong as a predictor as rule-based strategies ($\beta = .299$, $p = .05$). This suggests that rule-based strategies were a better overall predictor of high demand problem statement accuracy under low load than associative ones, although associative strategies still facilitated accuracy. Secondly, high demand problem statement accuracy under high load was regressed on reported strategy use (dummy coded). A significant model was found, $F(2,79) = 11.98$, $p < .001$, with rule-based

[24] The three levels of strategy use were dummy coded into two new variables *of rule-based* (which compared category 1 strategy use, rule-based, to the other categories) and *associative* (which compared category 2 strategy use, associative, to the other categories).

Table 5.3. Percentage of participants using each strategy under low load and under high load by experimental condition

	Mastery-Approach	Performance-Approach	No-Goal Control
Low Load			
Rule-Based	63%	21.4%	48%
Associative	25.9%	64.3%	40%
Random	11.1%	14.3%	12%
High Load			
Rule-Based	55.6%	17.9%	52%
Associative	40.7%	78.6%	32%
Random	3.7%	3.6%	16%

Note: Mastery-Approach, N= 27; Performance-Approach, N= 28; No-Goal Control, N= 25.

strategies sharing no relation with accuracy (β = .056, p > .05), but with associative strategies predicting accuracy (β = .536, p = .013). This suggests that when high demand problems are performed under high load, a rule-based strategy doesn't influence accuracy, interestingly rather than hindering accuracy as such, whereas an associative strategy appears to foster better accuracy for such problem statements.

Further analyses examining whether goal state group was related to strategy use revealed a significant association between experimental condition and high demand problem strategy use under both low (χ^2 = 10.428, df= 4, p = .034) and high (χ^2 = 15.725, df= 4, p = .003) secondary load. Under low secondary load, the use of a rule-based strategy was mostly evident amongst those in the assigned mastery-approach condition (63%), relative to those in the no-goal condition (48%), and to those in the performance-approach condition (21.4%) who demonstrated the least use of this strategy. The use of associative based strategies under low secondary load however was mostly strongly evident for those in the assigned performance-approach condition (64.3%), relative to those in the no-goal control (40%), and to those in the mastery-approach condition (25.9%) who demonstrated the most minimal reliance upon such strategies.

Under high secondary load, the use of a rule-based strategy appeared to be employed most by those in the assigned mastery-approach condition (55.6%), in comparison to those in the no-goal control (52%) and the performance-approach condition (17.9%). Thus suggesting that under high secondary load, those pursuing a mastery-approach goal were more evidently still attempting to use a rule-based strategy to solving problems. Also under high secondary load, the use of associatively driven strategies were being most predominantly relied upon by those in the performance-approach condition (78.6%) in comparison to those in the no-goal control (32%) and the mastery-approach condition (40.7%). Interestingly here, those in the mastery-approach condition although not reporting reliance upon associative strategies are evidently as those in the performance-approach condition, still appear to be using such strategies more than those in the no-goal control. Overall, results suggest that those pursuing a mastery-approach goal were relying more on a rule-based strategy relative to an associative strategy under low load. Although the percentage of those in this condition using an associative strategy increased but rule-based reliance decreased under high load, participants in this condition were still mostly relying upon a rule-based strategy under high load relative to an associative strategy. This suggests that those in the mastery-approach condition were more evidently attempting to still use a working memory intensive strategy even when there were less resources to facilitate such a strategy, which arguably contributed to a large decline in high demand problem statement accuracy from low to high load. On the other hand, those pursuing a performance-approach goal are less likely to employ rule-based strategies when demands are high, but are more likely to rely on an associatively based strategy when a task demands working memory, which arguably supported less of a decline in high demand problem statement accuracy from low to high load. The percentages in Table 5.3 illustrate that although addditional consumption of resources under high load appears to increase reliance upon assocaitve strategies for those in the mastery-approach and those in the performance-approach group (relative to those in the control), when use of associative stratgies under low load is considered, this change in strategy use is far less for those in the performance-approach condition.

Discussion

The present study examined the role of working memory in achievement goal pursuit by building upon the dual-task design of chapter 4 by employing a primary task known to vary in working memory intensity and including measurement of reported task strategies. Firstly, all participants regardless of goal group appeared to perform parts of a task which placed little demand on working memory similarly both under low and under high secondary load. Also as predicted, it was found that mastery-approach goal pursuit resulted in the largest decline in accuracy relative to those pursuing a performance-approach goal or a no-goal control - specifically on parts of a task which demanded working memory resources from low to high secondary load. This is consistent with the idea that higher load consumes the working memory resources that mastery-approach pursuit relies on for successful performance on high working memory demand tasks. Those in the no-goal control condition however did perform quite similarly to those in the mastery-approach condition, which arguably raises the question as to what a ‘no-goal’ condition actually entails. Results confirm that pursuit of a mastery-approach goal relies more heavily on the availability of working memory than performance-approach goal pursuit or a no-goal control.

It seems that self-reported strategy use could explain differences in the performance displayed by groups under high load. Specifically, reliance upon less working memory intensive strategies (associative) was more evident for those in the performance-approach condition, whereas reliance upon more working memory intensive strategies (rule-based) was more evident for those in the mastery-approach condition. Such strategy based findings again may help explain previous research demonstrating superior cognitive performance for a mastery-approach (Bereby-Meyer & Kaplan, 2005; Elliot et al., 1999; Escribe & Huet, 2005; Wolters, 2004), especially when a task is executively demanding (Barker et al., 2002; Graham & Golan, 1991; Wegge et al., 2001). That is, superior mastery-approach performance on cognitive tasks could be characterised by reliance upon more rule-based reasoning relative to performance-approach. What the present findings illustrate, is that when the resources necessary for such superior performance in effortful conditions are consumed, mastery-approach goal pursuit appears to continue to attempt to call upon a working memory intensive strategy. Findings are now discussed in detail, and implications for the design of the study to be present in the next chapter(6) will be drawn.

As expected, performance on low demand problem statements was similar under low and high working memory load. This demonstrates that the low demand problems did not draw strongly upon working memory resources. As such, if achievement goal states elicit differential use of working memory resources, manipulation of these sates was unlikely to yield effects on performance for these problems, even under high secondary load. However, as seen in figure 5.2, differences do emerge when performing high demand problem statements. Here, the performance advantage of mastery-approach pursuit under low load disappears under high load. Results suggest that being in a state of mastery-approach fosters greater reliance upon working memory relative to being in a state of performance-approach. Those in the performance-approach condition experience a smaller decline under high working memory load. Analyses of self-reported strategy use revealed that reliance upon more 'short-cut' strategies to complete parts of a task which do heavily demand working memory, may have attenuated the decrement in task performance for performance-approach pursuit under high working memory load.

Importantly, figure 5.2 also seems to indicate that those in the no-goal control similarly rely on working memory to those in the mastery-approach condition. This suggests that mastery-approach pursuit fosters no more reliance upon working memory than what pursuit of no goal would prompt, which contrasts with the findings specifically presented in chapter 4. Despite this, it still seems clear from the current findings at least that relative to a mastery-approach goal or no-goal, performance-approach pursuit fosters a less working memory intensive strategy. Overall one becomes more confident of the specific role of working memory in mastery-approach goal pursuit given that 1) those in a mastery-approach goal state experienced a larger decline in accuracy from low to high load on high demand problems relative to those in the no-goal control, and 2) that strategy analyses suggest that more participants in the mastery-approach condition were relying on a rule-based strategy under both low and high load in comparison to those in the control.

Findings from this study are broadly consistent with previous demonstrations that a secondary demanding task eliminates the performance advantage that those with relatively more working memory resources will typically demonstrate (Kane & Engle, 2002; Rosen & Engle, 1997). Given the similarity between the secondary working memory task in the current and previous chapter, there would be little doubt that the level of difficulty imposed by these secondary tasks differed and thus contributed to effects in any way. It is again possible as noted in the discussion section of the previous chapter study, that possible strategic differences underlie the chapter 3 (N-Back) findings. In that if performance-approach pursuit 'manages' high executive demand by turning to strategies that demand less working memory resources, then this could have contributed to poorer 3-Back performance as only a working memory intensive strategy would have facilitated performance under such conditions.

It is difficult to address exactly why mastery approach goal pursuit may involve less flexible adaptation, beyond that of inferring that this is the strategy more readily adopted when being in a state of developing self-referential competence. It is possible that those in a state of mastery-approach eschew the use of simple task strategies, given that this state orientates around improving skill. That is, although it might be clear to those pursing a mastery-approach goal that they could use a short-cut strategy, they perceive that it will only lead to suboptimal goal achievement and thus opt for the more intensive strategy, even when resources are limited. Alternatively, it may be the case that being in a state of mastery-approach actually makes individuals worse at detecting alternative, less attention demanding, task strategies. If reliance upon working memory intensive strategies allows individuals in a state of mastery-approach to 'develop competence', then this might make them less susceptible to directing their attention to alternative strategies. This idea would be consistent with research which has shown that those with more available working memory resources are better at focusing their attention on task properties and ignoring irrelevant information, whereas, those with less available working memory are less able to allocate attentional resources to one specific strategy (Conway et al., 2001). This would also be consistent with research which outlines that working memory availability provides more goal-directed control of attention, minimising interference (Lavie & De Fockert, 2005; see Lavie, 2010 for review). As such, continued investigation of the achievement goal-working memory strategy based relations would ideally benefit from utilising a task for which 'movement' to a (detection of an alternative less demanding task strategy) this idea could be more thoroughly and objectively addressed in comparison to the current study design. Overall, being in a state of mastery-approach may result in the favouring of understanding above all else, meaning that adoption of a strategy which might actually result in an incorrect response some of the time (associative in the present study) would be less likely to be employed.

Performance-approach pursuit on the other hand seemed to prompt reliance upon more associative task strategies both under low and high load. Reliance upon associative strategies argubaly made those pursing this goal less susceptible to experiencing a substantial decline in high demand problem performance. This argument is supported by the earlier regression analyses illsutrating that associative stratgies predict superior accuracy on high demand problems under high load. If differential reliance upon working memory between goal states reflects in task strategies employed, then the goal state which relies more on working memory, i.e., demonstrates this 'tendency' more evidently, should be performing more superiorly under low relative to high load, which mastery-approach pursuit clearly evidence. In other words, on the basis that high load denies the resources necessary for a rule-based strategy, then the goal state which typically relies most heavily on such a strategy should be most likely to 'suffer' under load, apparent for mastery-approach pursuit.

Although these present study task strategy analyses have been informative, all inferences above are based on open-ended, self-reported measures. It is quite possible that the independent coding of these strategies by the current thesis author into either a rule-based or associative category specifically, could have overlooked more subtle differences in working memory related strategy use. As such, further research within the current thesis (next chapter 6 study) would benefit from employing a task to examine goal effects for which reliance upon working memory related strategies is more evidently apparent from accuracy based performance alone. Furthermore, the current design only permitted examination of strategies employed when completing high demand problem statements (i.e., *"how you mostly solved the challenging problem statements"*). This in turn meant that any possible different strategies to solving low demand problem statements but which still allowed for these goal groups to perform consistently on such problems, went undetected. However, this design decision was firstly made on the basis that the low demand problem statements weren't challenging enough as such to allow for any strategy differences to significantly influence accuracy. Secondly, the key present interest lies in further exploring the accuracy and possible strategy differences specifically observed under high load in the previous chapter 4 findings, i.e., examining goal difference under conditions in which load consumes the resources that are normally demanded for successful task pursuit (i.e., high demand problem statements). Therefore, a focus specifically on high demand problem statement strategies is not deemed to have substantially limited the present study. Overall, a more objective, formal investigation of differential reliance upon strategies known to differ in working memory intensity between goal states would add to the current thesis considerably, and will be addressed in the forthcoming chapter 6.

An important point to make here is that in the present dual-task study and the study presented in chapter 3 (N-Back) participants assigned to a no-goal control performed more in line with a mastery-approach condition, relative to the performance-approach condition. However, in the previous dual-task study presented in chapter 4 the opposite was apparent. This raises concern over the extent to which one of these goal states is specifically working to enhance or whether one is working more markedly to limit, working memory engagement. What one can be sure of across these studies is that participants in this no-goal condition weren't induced into either a mastery-approach or performance-approach state (according to manipulation checks). However, one can't be sure that control participants weren't in some other kind of motivational state, which may have varied across these studies. Despite clear goal effect consistencies, this raises further research questions in terms of what is a 'control' condition in the context of achievement motivation. How likely is it to induce 'neutral motivation' in this context? As previously discussed in chapter 3, some researchers have advocated that the focus of motivational researchers should be on relative comparisons between achievement goals rather than comparisons between achievement goals and a control condition (Murayama & Elliot, 2011). Undeniably, direct comparisons between achievement goal states in the research presented in the current and previous two chapters has been insightful, but arguably so too has consideration of the relations between achievement goals relative to the performance of a control group. As such, it is argued that inclusion of a control group does offer interpretive meaning, however, although beyond the aims and scope of the current thesis, there is a clear research demand for attention to control group meaning in order to fully understand what the goal states of mastery-approach and performance-approach prompt beyond that of no achievement goal pursuit. Until this is addressed more fully, inferences regarding control group performance in examining the achievement goal-working memory relationship should be interpreted with caution. Consequently, the focus in the forthcoming chapter 6 will be specifically between a mastery-approach and performance-approach state.

As pointed out by other researchers employing dual-task designs to investigate the role of working memory (Deshon et al., 1996; Lavie & De Fockert, 2005), one must be aware of the possible influence of task switching. That is, that the design of both the present and previous chapter study in manipulating working load may have increased the demand on task switching. Although both low and high secondary load conditions adhere to a similar procedure, under low load participants are not necessarily required to actively store the memory sets (i.e., 01234, or, ABCDE) presented at the start of a trial whilst performing the primary goal pursuit tasks. Thus, under high load the need to switch from the memory set to the goal pursuit task was far more necessary relative to under low load. It is possible that such increased switching under high load may have interfered with working memory resources more than what high secondary load alone ideally should have done. This ultimately may have exaggerated primary task performance decline from low to high load, and possibly particularly for individuals who were relying more on strategies which required working memory resources (mastery-approach goal pursuit). This firstly highlights that examining strategy based working memory reliance differences between goal states under dual-task condition which similarly demand task switching under low and high load in future research would benefit this research area. But also, in the attempt of also avoiding task switching implications, that illustration of strategy based differences here under well designed single task conditions would also be beneficial (which will be specifically implicated in the study presented in the forthcoming chapter 6). Replication in the next chapter 6 study of the current pattern of strategy based findings for the achievement goal states specifically using a single task design but for which a less working memory intensive strategy is actually more optimal for performance, would make one even more confident in the present strategy based findings. Despite all this, on the basis that even under the low load (no switching) condition in the present study, goal states were still evidently relying on different, working memory intensive strategies to complete high demand problems, one is still confident in the differential role of working memory in achievement goal pursuit.

A final point to be made is with regards to the general issues surrounding the 'approach' nature of the manipulated goal states. Again in both the present and previous chapter study design, participants in both the mastery-approach and performance-approach conditions were being told that they had reached their target specific goal frames at the end of each task block (a design feature previously justified in the method section of chapter 4). Although this approach, success orientated feedback throughout the task blocks facilitated achievement goal manipulations, it is possible that some participants may have felt that previous task block success justified 'sitting back' a little on other task blocks, e.g., *"I did well on the previous task block so can sit back a bit on the current one"*. This may have dampened goal accuracy and strategy based effects, by increasing variability on these factors within goal groups.

For example, Van Yperen et al. (2009) speculate that telling participants pursuing achievement goals that they did well on a task block can increase feelings of contentment and thus increase the chance that those individuals don’t feel the need to try as hard in the next task block. Manipulation checks would suggest that this didn't influence the actual success of goal inducement, but further research specifically attending to the 'preservation' of goal achievement until the end of a task would be beneficial. This will be addressed specifically in the next chapter 6 study via implementation of a goal achievement reward system.

In sum, assessment of goal pursuit task strategies that vary in working memory intensity is a notable contribution of the current study. Mastery-approach pursuit clearly prompted more rule-based (step-by-step) strategies, which facilitated good performance on working memory intensive problem statements under low secondary load. However, the consumption of working memory resources under high load meant that these strategies (which require such resources) were no longer able to facilitate performance. Instead, continued reliance upon rule-based strategies, even when resources to support this strategy were limited, resulted in poorer performance for mastery approach goal pursuit. This seems somewhat fitting with research which suggests a mastery-approach focus fosters strong persistence (Wolters, 2004), and with research which shows that a mastery-approach focus can result in unintentional sabotage of achievement by increased engagement in tangential studying rather than strategically targeting learning objectives (Senko & Miles, 2007b). More importantly, this is consistent with research which has shown that maintenance or persistence with a complex, taught or learned strategy, is more evident for a mastery-approach focus relative to a performance-approach focus, with performance-approach having been found to divert back to more trial and error strategies when demands are increased (Bereby-Meyer & Kaplan, 2005; Escribe & Huet, 2005).

CHAPTER 6

Study 5

Overview of Chapter

The purpose of the current study is to examine the influence of achievement goal states on working memory engagement by a) moving beyond tasks which load working memory to investigating the effect achievement goals might have in other learning paradigms, b) using a task for which attentional demands, the role of working memory, are well known, and c) using a task for which formal modelling techniques can be applied to allow for the isolation of working memory dependent strategies. So far in the current thesis, experimental investigation has been primarily limited to gross measures of performance and thus this final experiment aims to reach more specific conclusions concerning the extent to which achievement goal states differentially engage working memory intensive learning strategies using a category-learning task. First, the role of working memory in category-learning will be discussed and then the appropriateness of category-learning for examining motivational influences will be reviewed. Current experimental design and findings will then be presented and inferences regarding the extent to which mastery-approach and performance-approach differentially recruit working memory intensive learning strategies will be outlined.

Background Review

The often complex decision processes that facilitate learning have been proposed to occur outside of and within conscious thought, the latter of which have been suggested to demand verbal working memory resources. This dichotomy is reflected in the *competition between verbal and implicit systems* theory (COVIS; Ashby, Alfonso-Reese, Turken, & Waldron, 1998), which proposes that there are two distinct category-learning systems. First, an explicit, hypothesis-testing system that relies on working memory is proposed to underlie rule-based category-learning.

Second, an implicit, procedural-based system that relies on reinforcement learning processes is thought to underlie information-integration category-learning. Rule-based tasks involve category structures that can be readily learned by an easy-to-describe rule. This rule is based on quantifiable or discriminable features of a presented simulus, and might be unidimensional (e.g., if a stimulus is high on feature X, then it belongs to category A, otherwise it belongs to category B) or multi-dimensional (e.g., if a stimulus is high on feature X and low on feature Y, then it belongs to category A, while if it adheres is low on feature X and high on feature Y, then it belongs to category B). Thus, with rule-based learning, information is combined to generate a response *after* a decision has been made about the values of the relevant dimensions. Therefore, such learning involves a process of trial and error and feedback, in which hypotheses are tested in order to 'discover' the optimal rule for making correct category decisions. Information-integration tasks, on the other hand, incorporate optimal category rules that are very difficult to verbalise (Ashby & Gott, 1988). In this case, learning is controlled via an implicit process in which relevant category dimension associations are reinforced from accuracy feedback provided in a more automatic, less time dependent, manner. With information-integration learning, information is combined to generate a response *before* a decision has been made about the values of the relevant dimensions.

Much support for the existence of these two systems comes from research which has shown that working memory load affects rule-based category-learning but not information-integration learning. For example, Waldron and Ashby (2001) got participants to learn both explicit and implicit category structures under single-task conditions and also when performing a simultaneous numerical Stroop task (a task known to require working memory; Bench, Frith, Grasby, Friston, Paulesu, Frackowiak, & Dolan, 1993). These to-be-learned structures consisted of (1) simple categorisation involving the use of a unidimensional rule (i.e., an explicit rule), and (2) complex categorisation requiring integration of information from three stimulus dimensions for which verbalisation of a rule was difficult (i.e., an implicit rule). The procedure involved participants classifying stimulus as either belonging to category A or B according to either the rule-based or information-integration structure, with the addition of remembering which of two numbers presented to the right and left of the categorisation stimuli on a computer screen was physically larger and which was numerically larger in the concurrent task condition (simultaneous Stroop task). The participants were required to make this numerical response after they had made a categorisation decision, to ensure that during the process of making the categorisation decision the participant had to hold in memory the numerical information. Results showed that the concurrent numerical Stroop task substantially impaired learning of simple explicit rules but did not disrupt learning of complex implicit rules (Waldron & Ashby, 2001).

A further study by Maddox, Ashby, Ing, & Pickering (2004) showed that presentation of a working memory task performed immediately after the presentation of category decision feedback impaired rule-based learning but did not affect information-integration learning. This further supports the notion that rule-based learning is working memory dependent, because corrective feedback clearly needs to be explicitly linked with rule based responses made. Other studies have demonstrated that rule-based performance is better when full feedback on category responses is provided. This is attributed to the fact that the explicit learning system is better able to discriminate between competing hypotheses when detailed feedback is provided (Maddox, Love, Glass, & Filoteo, 2008). The procedural system, on the other hand, does not benefit from such detail as it uses reinforcement learning and is only concerned with the simple valence of feedback. Overall, these findings not only provide support for the existence of multiple category-learning systems, they additionally suggest that one is more working memory dependent than the other.

Importantly, COVIS suggests that these two key explicit and implicit systems compete with each other during learning, with one ultimately dominating responses. Individuals are typically biased in applying simple explicit unidimensional rules during the initial stages of learning (Bruner, Goodnow, & Austin, 1956; Shepard, Hovland, & Jenkins, 1961). When an explicit rule is discovered it then often dominates, but when an explicit rule does not lead to accurate category decisions then a gradual shift to the procedural system is believed to occur (Zeithamova & Maddox, 2006). This has interesting implications regarding the role of, or reliance upon, working memory in category-learning. For example, Zeithamova and Maddox (2006) found that performance on an information-integration task was slightly poorer under dual task conditions (i.e., when performing a simultaneous working memory task) relative to a single information-integration categorisation task condition. From this, the authors suggested that attention consumed by a dual working memory task may (1) reduce the cognitive resources needed for initial rule-based hypothesis testing, and/or, (2) slow down the shift from the explicit to the implicit system. This highlights the possibility that, although a secondary working memory task is less likely to hinder information-integration learning relative to rule-based learning, it may still delay the engagement of the implicit system, arguably confirming the initial dominance of explicit hypothesis testing.

A more recent examination of the effect of a secondary working memory task on category-learning further highlighted the benefit of reduced working memory resources for information-integration learning. Filoteo, Lauritzen and Maddox (2010) demonstrated that inclusion of a third irrelevant stimulus dimension in addition to two relevant dimensions, had a negative impact on conjunctive (explicit) and information-integration category-learning. This was found to be due to a decrease in the number of participants trying out implicit strategies but an increase in reliance upon a unidimensional rule. These authors found that the addition of a sequential working memory task then improved information-integration learning but had no effect on accuracy in the conjunctive condition. Such findings revealed that this improvement for information-integration was due to a decrease in the use of unidimensional rules and an increase in use of an implicit strategy (Filoteo et al., 2010). Thus, competition between the explicit and implicit system is being specifically implicated here. Findings therefore show that the sequential task engaged working memory so that the implicit learning system could then take control of performance on the primary category-learning task, further inferring that less working memory is potentially more in terms of information-integration learning. Considering this in terms of achievement goal pursuit, one would predict that the goal state which engages more working memory will inherently rely more on the use of explicit rules even on an information-integration task, and will therefore be less likely to abandon such a strategy.

Researchers have critically suggested that in many of the studies just described, the selective effects of load should be questioned (Nosofsky & Kruschke, 2002; Stanton & Nosofsky, 2007). For example, Newell, Lagnado, and Shanks (2007) found that a concurrent memory task actually had greater detrimental effect on an implicit categorisation task relative to an explicit version of the same task. Also, Stanton and Nosofsky (2007) argue that the often observed pattern of results regarding rule-based and information-integration performance under load is actually an effect of perceptual discriminability, confirmed by the finding that learning on an information-integration task with low perceptual discriminability is impaired by memory scanning load. Despite this, single task designs still appear to confirm a multiple-systems approach. Researchers have examined the extent to which individual differences in working memory capacity relate to category-learning performance. DeCaro, Thomas and Beilock (2008) found that the higher ones working memory capacity, the fewer trials it took to learn rule-based categories, but also that, the lower ones working memory capacity, the fewer trials it took to learn information-integration categories. Such findings are explained by the suggestion that individuals with superior working memory capacities more readily adopt explicit, complex strategies, which ultimately facilitates optimal rule-based learning, but, harms information-integration performance by limiting the opportunity for the procedural, implicit, based system to be engaged. Thus, when less working memory is engaged to in order to learn, the faster optimal information-integration structures are learnt.

It is imperative to note that re-examination of DeCaro et al. (2008) findings revealed that superior performance on information-integration tasks of those low in working memory, are on occasions more attributable to reliance upon simple rule-based strategies which avoid heavy working memory dependence but still allow for above chance accuracy (DeCaro, Carlson, Thomas, & Beilock, 2009; Tharp & Pickering, 2009). This is interesting, as quickly achieving accuracy on an information-integration task may not necessarily always represent quicker engagement of the implicit, procedural learning system, but rather engagement of simple explicit rules. Either strategy would make little demand on working memory resources. Arguably, this is consistent with other research findings demonstrating that individuals lower in executive function abilities often solve problems using simple strategies (Beilock &

DeCaro, 2007; Ricks, Turley-Ames, & Wiley, 2007). This overall highlights the particular value and importance of being able to ascertain qualitatively different strategies engaged during a category-learning task, and is why, formal modelling techniques (e.g., Ashby & Maddox, 1993) are often used to explain which response strategies are actually being adopted (i.e., statistical modelling formulations to differentiate whether an explicit or implicit based rule was actually being utilised).

Such evaluations of the literature have contributed much to understanding the role of working memory in category-learning. It is important to point out that in re-examining their own work, DeCaro et al. (2009) found that higher working memory actually led to quicker learning in both a rule-based and information-integration task. This, in addition to the early concerns discussed regarding the selective effects of secondary load, raises some concern with the extent to which one can specifically implicate less working memory engagement for superior information-integration performance. Other results are not necessarily consistent with this however. When category-learning tasks are designed so that it is not possible to use simple unidimensional explicit rules, working memory does seem to delay the discovery of implicit rules. For example, Markman, Maddox and Worthy (2006) got participants to complete an information-integration task either under a low (‘*do your best’*) or high (‘*exceed a performance criterion*’) pressure inducement manipulated via task instructions, with the high pressure inducement known to reduce the availability of working memory (Beilock & Carr, 2005). It was found that those in the high-pressure condition had enhanced information-integration performance, again suggesting that when in a state of reduced working memory capacity, one is less likely to adopt an explicit multidimensional strategy, but is more likely to abandon such a rule-based strategy, in favour of engaging the implicit system more readily. In other words, the high-pressure manipulation over engaged working memory, leaving less available for the task thus allowing for quicker engagement of the procedural system. Overall, research findings clearly suggest that working memory may influence what category-learning strategy is most readily adopted, and indeed that engagement of working memory may be particularly harmful to information-integration task performance. This is fundamentally consistent with executive-attention theories (Kane & Engle, 2000; Rosen & Engle, 1997) as discussed in chapter 1. Individuals with more available working memory capacity are better at directing their attention toward task relevant information. This in turn means that attention for such individuals is more likely to be distributed across stimulus dimensions in a categorisation task arguably prolonging hypothesis testing, or at least being more likely to prompt multidimensional hypothesis testing.

Interestingly, Markman et al's. (2006) study illustrates how the understanding of differential working memory dependency of the two systems has been used to test and confirm the extent to which particular motivational states might be working memory dependent. For example, these authors used a motivational based manipulation which focused participants on achieving above a performance criterion. Markman et al. (2006) told individuals in the high-pressure condition that if they exceeded a performance criterion they would earn a reward. This led these authors to then conclude that pursuit of a conditional outcome-based goal diverts working memory resources away from the primary task of interest. Further research has addressed this in more detail, with findings illustrating that inducing a performance-contingent outcome goal specifically harms rule-based learning. Conversely, manipulations that induce explicit monitoring of ones performance and heightened attention to skill processes specifically hurt information-integration learning (DeCaro, Thomas, Albert, & Beilock, 2011). This led these to the interesting conclusion that motivational manipulations which serve to shift focus of attention to the consequences of ones performance and outcome possibilities hinder skills that rely on working memory. However, when manipulations serve to increase attention to awareness of being monitored, it seems to increase the likelihood of attention to step-by-step, working memory reliant, skill execution, hence why information-integration learning is disrupted (Markman et al., 2006).

This raises a very important point: Two competing theories as touched upon in the previous chapter are the distraction hypothesis, which proposes that pressure leads to a decrease in resources (Wine, 1971), and the explicit monitoring hypothesis, which proposes that pressure increases attention to skill-focused processes that disrupt performance of proceduralised tasks via increased reliance upon resources (Baumeister, 1984). Considering these hypotheses and the findings of Markman et al., (2006) it seems difficult to place effects of achievement goal pursuit. That is, both a mastery-approach and performance-approach goal (on the basis of the manipulation procedures being used in the current thesis) involve focusing on *both* performance-contingent outcomes (i.e., *to do better than*) and skill execution (i.e., self-referential and normative competence). It is possible that if a mastery-approach focus is more concerned with actually developing skill (i.e., task mastery) that the explicit monitoring hypothesis is more relevant, and thus such goal pursuit increases reliance upon working memory resources and disrupts procedural learning. In contrast, if a performance-approach pursuit is more concerned with ultimately outperforming others there is more of a reduction of available working memory resources according to the distraction hypothesis for this goal state.

An extension of such findings involved Worthy et al. (2009) investigating the performance of expert classifiers (i.e., those extensively trained on a rule-based or an information-integration task) under very high pressure, high stakes, motivational instructions. These authors informed participants that they would receive a substantial monetary bonus by focusing on performing perfectly in a task round, thus, the purpose of trying to achieve a bonus was self-serving and involved no normative component. Findings suggest that participants who had been extensively trained in rule-based learning performed more poorly under such a manipulation than participants who had been trained in information-integration learning. Worthy et al. (2009) suggested that information-integration performance was not hindered because such participants were more immune to the damaging effects of explicit monitoring that such a high-pressure condition promotes. Such immunity had been achieved because earlier extensive training in information-integration learning had prevented them obtaining explicit knowledge about category structures. This research is of value to the current chapter study, as it illustrates that not only have category-learning frameworks been previously successfully investigated under motivational manipulations, but also that such a design offers much in terms of making working memory related inferences about motivational manipulations applied.

Offering further relevance to the current chapter study, as briefly touched upon in chapter 1, the regulatory states of *promotion,* an approach focus on the presence or absence of gains in the environment, and of *prevention*, an avoidance focus on the presence or absence of losses in the environment (Higgins, 1997), have been found to have a differential effect on category-learning. It is firstly important to outline that inducing a promotion focus often involves offering a participant a reward if they exceed a performance criterion, whereas, a prevention focus often involves the provision of a reward and loss of this reward if a performance criterion is not exceeded. In both cases, when being examined within a category-learning framework, participants are often provided with a 'points scale' on the screen in front of them which allows them to track their task points total relative to the set performance criterion (Maddox, Baldwin, & Markman, 2006). Secondly, it is important to note that research has shown that when the reward structure of a task matches these motivational foci (e.g., when a situational promotion focus is matched with a gains reward task structure, or, a situational prevention focus is matched with a losses reward task structure) there is a noted increase in cognitive flexibility (Markman, Baldwin, & Maddox, 2005). That is, when given so-called regulatory fit, ones willingness to select and test different strategies during goal pursuit increases. Thus, when such flexibility is advantageous performance should be better when in a regulatory fit, but when cognitive flexibility is disadvantageous then performance should be better when in a regulatory mismatch.

It is through this exact proposition that regulatory fit is suggested to affect category-learning. Maddox, Baldwin and Markman (2006) found that when cognitive flexibility was advantageous on a rule-based task (i.e., as such flexibility increased the likelihood of hypothesis-testing), those in a regulatory fit were quicker to learn and to also shift towards the most optimal explicit rule. Also, when performing an information-integration task for which cognitive flexibility was disadvantageous (as it would prevent optimal implicit learning), those in a regulatory fit took far longer to shift from rule-based strategies towards more appropriate information-integration (Maddox et al., 2006). Other studies continue to confirm such an effect, with participants in a regulatory mismatch performing better on information-integration tasks relative to those in a regulatory fit, while those in a regulatory fit perform better on rule-based tasks relative to those in a mismatch (Grimm et al., 2008). It could be argued that this pattern of effects is confounded by heightened difficulty of an information-integration task relative to a rule-based one. However, it is noted that even when more difficult rule-based tasks are used, similar results are found (Grimm et al., 2008). This has led to the conclusion that being in a regulatory fit leads to an increase in executive working-memory resources, whereas being in a mismatch causes decrements in available executive resources (Worthy et al., 2009). It is further suggested that the reason a fit leads to increases in executive control is because of a heightened feeling of confidence in performance, whereas, a mismatch is more likely to promote feelings of worry and anxiety about ones performance which thus decreases executive resources (Aaker & Lee, 2006; Worthy et al., 2009). Overall, these findings are arguably consistent with previously described research relating to working memory and category-learning, in that regulatory based motivational manipulations appear to affect working memory which appears to be reflected in category-learning strategies and performance. Attention to this research also outlines that any examination of approach based achievement goals and category-learning should perhaps be examined using a task structure which ensures regulatory fit (i.e., a gains based task) in order to prevent any unnecessary reductions in resources.

Findings discussed in this opening chapter review highlight valuable avenues for research addressing the achievement goal-working memory relationship. Firstly, the types of pressure and regulatory motivation manipulations reviewed are similar to features of achievement goal state manipulations. These manipulations have included inducing a focus on achieving above set performance criteria, skill processes, social based performance, and doing well for ones own benefit. The difficulty with making specific inferences about the overlap with these manipulations and the two key achievement goal states of interest in the current thesis is that, as discussed in this chapter background review, many of these manipulations have (1) included links to monetary rewards, (2) manipulated the reward structure of the category-learning task, (3) been designed to induce high anxiety, (4) varied the potential of positive and or negative outcomes, and (5) some within-subject manipulations have incorporated both mastery and performance elements (e.g., DeCaro et al., 2011; Worthy et al., 2009). Thus although making specific inferences about the direct relevance of discussed findings to mastery and performance goal states is arguably confounded, overall the use of related motivational manipulations on category-learning tasks is somewhat encouraging.

Although concerns have been raised with regards to implicating multiple-system accounts, research discussed seems to suggests that engagement of working memory resources is essential for rule-based learning, but is likely to harm information-integration learning. Thus, bearing all the research discussed in mind, category-learning tasks are a valuable framework to examine the potential learning implications of motivational states that appear to impact on working memory use (as per the findings in previous chapters in this thesis). Information-integration tasks are to be specifically considered here. Therefore, in line with the theoretical framework of COVIS and research discussed, it can be suggested that if a state promotes enhanced working memory engagement then one is more likely to observe utilisation of explicit, verbalisable rules, ultimately slowing information-integration learning and/or preventing optimal performance on an information-integration task. On the other hand, if a state fosters reduced reliance upon working memory, one is possibly more likely to observe engagement of the procedural learning system more readily, ultimately facilitating more optimal information-integration performance.

In line with previously discussed current thesis findings from chapters 3, 4 and 5, it is predicted that if a mastery-approach state promotes heavy engagement of working memory resources to perform well, then pursuit of this goal should prevent optimal progression on an information-integration task due to heightened hypothesis-testing. In other words, this state should prolong engagement of the explicit system due to perseverance in considering complex verbalisable rules. This is likely to be reflected in suboptimal performance on an information-integration task due to longer reliance upon more multidimensional rules. Arguably, this should be most notable early on in an information-integration task (lower accuracy) and within this period use of rule-based strategies should be more evident. In sum, the tendency of this goal state to rely on working memory resources will increase confidence in more explicit hypothesis testing which will be misplaced on an information-integration task.

If a performance-approach state promotes less reliance upon working memory resources, then pursuit of this goal state should result in either a) very limited progression or poor overall performance on an information-integration task due to unidimensional rule testing, or b) rapid abandonment of explicit hypothesis testing and engagement of the implicit system, evidenced by more optimal progression on an information-integration task. If the first of these scenarios prevails then the use of undimensional rules should be most evident. If the second prevails then increases in accuracy should be earlier in learning (relative to mastery-approach) and an information-integration strategy should be more evident. A caveat to this is that if participants in this condition vary somewhat in either of these strategies, then the combined effects may lead to no association with task accuracy. Regardless, one is attempting through achievement goal state manipulations, to influence the competition between rule-based and information-integration learning.

These propositions are tested in the present chapter study. In order to test these, it was necessary to employ a classification task for which variations in the amount of working memory engaged would lead to observable performance differences. An information-integration task is being selected to examine differential effects of achievement goal states. The category-learning task used in the present study is based upon that described by Filoteo et al. (2010). The three-dimensional information-integration task condition described by Filoteo et al. (2010) (II-3D) was used in the present study but with the sequential working memory task removed. Participants performed this task under one of two possible conditions; an experimentally manipulated mastery-approach or performance-approach state. No control group was used in the current study as will be outlined and discussed in the method section of this chapter. Optimal performance on the task is predicted by information-integration learning, i.e., engagement of the implicit learning system. Importantly, working memory capacity is assessed and accounted for in the present study. Furthermore, in an attempt to consider and eliminate possible state-anxiety and trait goal orientation effects, measures of these variables were also included in the present study.

Method

Participants

Fifty University of London students from various disciplines (37% psychology students) took part in the current research and all were paid £5 for their participation. To ensure that participants had understood task instructions and achieved minimal learning (i.e., to ensure that an attempt to learn to categories was made rather than random guessing), those who didn't achieve at least 55% accuracy in the final block of trials were not included in analyses. This resulted in removal of 1 participant (who achieved 53% in the final task block[25]) resulting in a final sample of 49 participants (57.1% female). Age was recorded in 1 of 5 ranges (18-25; 26-35; 36-45; 46-55; 56-65) with a modal range of 18-25 years accounting for 62% of the sample. All participants had normal or corrected to normal vision. Informed consent was obtained prior to participation.

Category-learning Task

The three-dimensional information-integration task employed by Filoteo et al. (2010) briefly discussed in the background review of this chapter, was used. The three-dimensional stimuli consisted of single lines that varied along two relevant dimensions of length and orientation and one irrelevant dimension of horizontal spatial position (i.e., where the line appeared along the left/right axis of the screen). Each stimulus presented belonged to one of two possible categories, either category A or B. Either of the relevant stimulus dimensions (length or orientation) could be used individually as a unidimensional rule to achieve up to 75% accuracy. The third irrelevant dimension of horizontal spatial position could still be used as a unidimensional rule, but would result in a maximum of only 50% accuracy. More reasonable, but still suboptimal, performance could be achieved by employing a conjunctive rule involving the two relevant dimensions, which would yield a response accuracy of up to approximately 86%. The category structure used in the task was probabilistic, not deterministic, meaning that no response strategy would yield 100% accuracy. The optimal accuracy was 95% and achievable only by an information-integration rule involving the relevant dimensions. The information-integration rule

[25] The data of the participant that was excluded was best fit by a guessing model on each task block (see Learning Strategy Modelling subsection of Results for a more detailed explanation of this guessing model).

can be defined as “If orientation is greater than length, respond A, otherwise respond B" (see figure 6.1). Importantly, as will be described in more detail in the *manipulation of achievement goal states* subsection, all participants were attempting to achieve a performance criterion of 85%. Filoteo et al. (2010), reported average accuracies of between 70% and 80% towards the final task blocks, and thus 85% was deemed an appropriately challenging target to set in the current study. This target level was deemed important as a lower (easier) target would arguably be too 'working memory light' which might reduce the chance for achievement goal states to impact task performance. In other words, consistent with previous research (Barker et al., 2002; Murayama & Elliot, 2011; Wegge, 2001; Wegge, et al., 2001), a challenging target was deemed necessary in order for goal effects to actually emerge. This challenging target would also therefore be likely to keep working memory engaged for longer, according to COVIS, but with the prediction that those in a mastery-approach state will be more likely to take advantage of this via prolonged testing of conjunctive rules. Conversely, those in a performance-approach state will be more likely to 'coast' with a simple unidimensional rule, or disengage from working memory use and adopt an implicit strategy. Thus, both a conjunctive and an information-integration rule would allow participants to reach their set target of 85%, but optimal performance was only possible through reliance upon the information-integration rule. The stimuli are detailed in figure 6.1, which shows a scatter plot of the stimuli across the two relevant dimensions of length and orientation. The parameter values from which the stimuli were sampled to create the categories are shown in table 6.1.

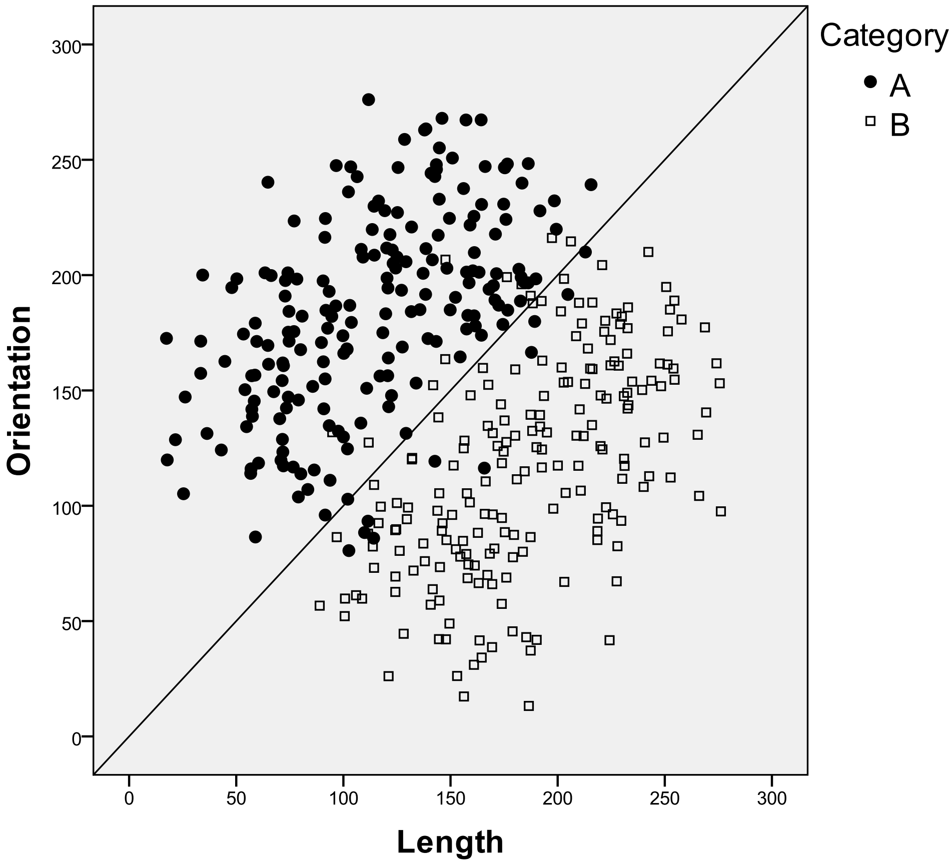

Figure 6.1. Illustration of the category structures. The solid line denotes the optimal decision boundary and each cluster of stimuli is associated with a specific category (A or B). Values of the stimulus dimensions are in arbitrary units. Each stimulus was created by converting the x value of these units into a line length (measured in pixels) and the y value (after applying a scaling factor of π/500 to approximately equate the salience of length and orientation) into line orientation.

Participants completed 4 blocks of 100 trials per block and the task was presented with a 1366 x 768 screen resolution. Based on the results of Filoeto et al. (2010), four task blocks were deemed efficient in order to actually allow for and observe learning effects. All participants were informed via written standardised task instructions presented on a computer screen at the very start of the task that they would be shown pictures that consisted of a single line which varies in length, the direction it is oriented, and its location on the screen. They were then informed that they were required to categorise these pictures whereby if they felt that a picture was

Table 6.1. Category-Distribution Parameters for the Length and Orientation Dimensions.

	Parameter			
	M_l	M_o	Σl	σo
Category				
A	80	150	30	30
A	150	220	30	30
B	150	80	30	30
B	220	150	30	30

Note: Dimensions are in arbitrary units; see Figure 6.1 for scaling factors. The subscripts ‘l’ and ‘o’ refer to length and orientation, respectively. The irrelevant dimension (horizontal spatial position) had a mean of 150 and a standard deviation of 60.

an 'A' they should press the key labelled A (key Z on a standard QWERTY keyboard), or if they felt that the picture was a 'B' they should press the key labelled B (key M on a standard QWERTY keyboard). They then read that they would be told whether or not they correctly categorised each picture presented, and that there would be an equal number of pictures that belong to category A and B. Participants were also informed in instructions that there would be a number of task blocks, but the exact number was not given nor was the number of trials per block indicated to participants (in order to control any differential 'achievability' perceptions).

On each trial, stimuli consisting of a single white line within a black boxed background bordered by a white line were presented. As previously noted, the length, orientation and horizontal spatial position, varied on each trial. Additionally, to the upper right hand side of the computer screen the target performance criterion (85%) was displayed throughout each task block, for which presentation varied according to experimental condition and will be described in more detail within the *manipulation of achievement goal states* subsection. On each trial, stimulus pictures remained on screen until the participant generated a response by pressing either of the labelled keys. Standard corrective feedback was then immediately provided in the form of a

500 ms presentation of the word 'Correct' (if a correct response had been made) or 'No, the correct response is A/B' (as appropriate) just below the stimulus presentation box on screen. This visual feedback was accompanied by auditory feedback, with correct responses accompanied by a 'cash register' sound (in line with an associated lottery to be described in the *manipulation of achievement goal states* subsection), whereas incorrect response feedback was accompanied by a 'buzzer' sound. Following feedback presentation, there was a 250ms inter-trial interval and then the next trial commenced. Throughout the task, participants also received a feedback update on their current average accuracy for the past 20 trials. Thus, in addition to the standard category response feedback, after every 20th trial (i.e., 20th, 40th, 60th and 80th trial within each block), participants average accuracy over the previous 20 trials flashed up on screen as 'Current Accuracy: X%' for 1000ms (presented just above the stimulus presentation box). This served to keep the participant updated with their performance progression and will be discussed in more detail within the upcoming *manipulation of achievement goal states* subsection. At the end of each block of trials, a summary of the participant’s performance (including their overall average accuracy for the preceding block) and implications for future task blocks was presented. Again, this information concerned an associated lottery and was specifically framed according to experimental condition and will thus be described in more detail below.

Manipulation of Achievement Goal States

This information-integration task was performed under one of two possible experimental conditions: a mastery-approach goal (MAG) or performance-approach goal (PAG). Unlike the work presented in chapters 3 to 5, a control group was not included in the current study design. As discussed in detail in the discussion section of the previous chapter 5, this was on the basis of issues relating to the 'interpretive meaning' of a control within an achievement motivation context. The primary interest in the current study was therefore to examine the employment of working memory intensive learning strategies between achievement goal states specifically. Goal states were manipulated again in line with the meta-analytic findings presented in chapter 2. Participants in both conditions were aiming to achieve the same numerical accuracy target, just framed differently according to a task purpose and goal frame manipulation.

In both the MAG and PAG condition participants were first provided with standard category-learning task instructions as described in the previous subsection. Following this, participants in the MAG condition read the following set of instructions:

"The purpose of this task is to develop your own skill at detecting category memberships. As such, your goal is to achieve above 85% accuracy, which is a good representation that you have mastered the category memberships, and thus have developed your skill at the task."

"The task will be divided into a number of blocks. The category memberships are the same in each block of trials. Your goal, to develop your own skill at classifying each picture to the appropriate category, remains the same throughout."

"During each block of trials, your mastery target of 85% accuracy will remain on screen as a reminder. Every so often your current percentage accuracy will flash

up on the screen so you can see how well you are developing your skill at the task as you go."

In contrast, those in the PAG condition read the following set of instructions:

"The purpose of this task is to demonstrate your skill at detecting category classifications well in comparison to other participants. As such, your goal is to achieve above 85% accuracy, the average of the best performing participants who have already taken part, in order to show that you have performed well relative to others at the task."

"The task will be divided into a number of blocks. The category memberships are the same in each block of trials. Your goal, to demonstrate your skill at classifying each picture to the appropriate category well in comparison to others, remains the same throughout."

"During each block of trials, your performance target of 85% accuracy will remain on screen as a reminder. Every so often your current percentage accuracy will flash up on the screen so you can see how well you are demonstrating your skill at the task in comparison to others as you go."

Importantly, rather than framing 85% as the overall student average in the PAP condition as it has been in earlier studies within the current thesis, this target was framed as the average of top performing students to make this particularly challenging target more believable[26]. Participants in both conditions were aiming for the same numerical target of 85%, therefore importantly not confounding the actual goal manipulation with differences in task difficulty. Following presentation of the instructions, but prior to commencement of the task, all participants were informed that if they achieved their target goal at the end of the task by *'mastering the task'* (MAG) or '*performing well on the task in comparison to others'* (PAG), that they would win a ticket for entry into a prize draw for £25 cash. This served to maintain interest in goal pursuit, but more importantly allowed for achievement goal state relevant feedback to be provided at the end of each block of trials. In contrast with the work presented in chapters 4 and 5, where numerical targets and between block information was standardised, participants have to be given *true* feedback on their performance in order to actually be able to progress in learning the categories. It is highly important that achievement goal manipulations are not confounded by success versus failure feedback during the task. Therefore, rather than making average accuracies achieved on a task block decisive or conclusive in any way, introducing this lottery allowed for between-block information to merely serve as a summary of progression made. At the end of each block participants receive a summary on their performance for the preceding block. This involved informing participants via the computer screen that if the preceding block had been the final block of trials, then they would have earned their lottery ticket (if average accuracy was above the set performance criterion), or they were encouraged to keep trying to achieve their goal (if average accuracy was below the set performance criterion). Any unnecessary reduction in the availability of working memory resources imposed by this reward

[26] This decision was based on piloting results, in which some participants questioned the plausibility of 85% being a average of students to have taken part in the study so far.

structure, being gains based, under pursuit of either of these approach based goals was not foreseen.

Participants in the MAG condition who had achieved an average block accuracy above the performance criterion of 85% at the end of a task block were told:

'You reached above the mastery target of 85% accuracy in the last round and are thus achieving your goal of developing your own skill at the task. Keep on trying to develop your skill at the task by achieving above your mastery target of 85% and you will be on track for being entered into the cash lottery!'

Alternatively, if those in the MAG condition had achieved below the performance criterion of 85% at the end of a task block they were told:

'You did not reach your mastery target of 85% accuracy and need to keep focused on achieving your goal of developing your own skill at the task. Keep on trying to develop your skill at the task by achieving above your mastery target of 85% and you will be in with a chance of being entered into the cash lottery!'

In contrast, participants in the PAG condition that had achieved an average block accuracy above the performance criterion of 85% at the end of a task block were told:

'You reached above the performance average target of 85% in the last round and are thus achieving your goal of demonstrating your skill at the task in comparison to others. Keep on trying to demonstrate your skill at the task in comparison to others by

achieving above the performance average target of 85% and you will be on track for being entered into the cash lottery!'

Alternatively, if those in the PAG condition had achieved below the performance criterion of 85% at the end of a task block they were told:

'You did not reach your performance average target of 85% accuracy and need to keep focused on achieving your goal of demonstrating your skill at the task in comparison to others. Keep on trying to demonstrate your skill at the task relative to others by achieving above the performance average target of 85% and you will be in with a chance of being entered into the cash lottery!'

Unlike the studies presented in chapters 4 and 5, the feedback information presented at the end of each block was not centred around whether a goal had been achieved or not, and the setting of new targets for subsequent blocks. Rather, it served to summarise that the participant either needed to continue to do well in order to achieve their goal by the end of the task (intended to prevent the perception that success didn't need to be maintained), or keep trying in order to achieve their goal by the end of the task (limiting the perception that progression and goal attainment could not be made), for an above or below criterion average block accuracy respectively. Such information also served as between block goal prompts (in accordance with meta-analytic findings presented in chapter 2). In accord with ethical concerns for equity, all participants – including those that had not achieved above the performance criterion - were congratulated on doing well and told as such that they would be receiving a lottery ticket for their efforts.

Finally, as previously mentioned, to ensure participants were kept updated with the actual assigned task purpose and goal framework according to their experimental condition, the 85% performance criterion remained in the upper right hand corner of the computer screen throughout each task block. For those in the MAG condition this read *'to master the task, your target accuracy is 85%'* and for those in the PAG condition this read *'to perform above the student average, your target accuracy is 85%'*. All task instructions, goal instructions and between block information was read by participants directly from a computer monitor.

Measures

Trait Goal Orientation. As measured in chapters 3 to 5. Elliot and Murayama's (2008) Revised Achievement Goal measure was used (internal consistencies of .85 and .83) for trait mastery-approach and performance-approach scales respectively.

Working Memory Capacity. As measured in chapters 3 to 5. The Operation Span (OSPAN) task (Turner & Engle, 1989) was used to measure individual differences in capacity.

State-Anxiety. As measured in chapter 5. The State form of the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1970) was used to assess experiences of anxiety during task performance ($\alpha = .91$).

Manipulation Checks

Importantly, manipulation checks were taken after all participants had been told they would still be receiving a lottery ticket (even if they hadn't achieved above 85% as previously described). This was with the aim of ensuring that the effect of any post-task emotions relating to lack of achievement on checks were as controlled as possible.

Goal Recall: Task Purpose and Goal Assigned. Both as measured in chapters 3 to 5.

Goal State. As measured in chapters 3 to 5. State adapted forms of the mastery-approach and performance-approach scales from Horvath et al. (2001) Global Goal Orientation measure were utilised. Internal consistencies of .82 and .92 were demonstrated for state mastery-approach and performance-approach scales respectively.

Goal Commitment. As measured in chapters 4 and 5. Items were taken from the Hollenbeck et al. (1989) Goal Commitment scale with an internal consistency reliability of .72.

Procedure

Participants were tested in the same sound proof laboratory as used in the studies presented in chapters 3 to 5. Written consent was initially obtained and demographic and trait goal orientation items then completed. Participants then completed the OSPAN task, after which they were given a 5 minute break (but remained in the testing room). Given the need for participants to be unfamiliar with the category task so that prior experienced didn't confound possible learning differences within and between groups, all participants at the end of the 5 minute break were given a very brief overview of the categorisation nature of the upcoming task and asked if they had taken part in a similar task before. No participant claimed to have been over familiar with the task.

After the 5 minute break, participants then completed the category-learning task. They were told they were about to complete a categorisation task before reading the computerised task instructions and goal manipulation instructions as previously described. The experimenter then asked if they had any questions, and if so, verbally responded by restating the necessary parts of the task and/or goal instructions. The experimenter then left the testing room and the participant started the task by pressing the spacebar. After completing the task, the experimenter returned to the testing room and all participants completed (in counterbalanced order) the questionnaires assessing Goal Recall, Goal State, state anxiety and goal commitment. Finally, all participants then received a thorough debriefing on the purpose of the experiment, were provided with a lottery ticket, and were thanked for their participation. This entire procedure lasted approximately 70 minutes.

Results

Manipulation Checks

Chi-square tests of independence confirmed that participants' post-task reported purpose, $\chi^2 = 41.66$, $df = 3$, $p < .001$, and assigned goal, $\chi^2 = 34.67$, $df = 3$, $p < .001$, was consistent with their experimental condition. There were no significant differences in reported goal commitment between the participants in the MAG (M = 20.83, SD = 3.32) and PAG (M = 20.48, SD = 3.11) condition (p = .70), with both group commitment means indicating strong commitment to goals assigned. Goal State checks revealed significant differences in reported state performance-approach, $t(47) = 5.72$, $p < .001$, with those in the PAG condition (M = 14.68, SD = 4.0) scoring higher in this state than those in the MAG condition (M = 8.96, SD = 2.9). However, there were no significant differences between groups on self reported state mastery-approach, $t(47) = .261$, $p = .80$, thus raising some concern as to whether those in the mastery-approach condition ($M = 13.50$, $SD = 2.90$) had a heightened experience of this state than those in the performance-approach condition ($M = 13.24$, $SD = 4.0$).

In sum, the inducement of performance-approach appears to have been effective overall. Although those in the assigned mastery-approach condition recalled and understood their assigned task purpose and goal, they did not report a greater experience of state mastery-approach compared to those in the performance-approach condition, during task performance. Consideration of the means for both conditions on self reported state mastery-approach, seem to suggest here that both groups appear to report a reasonable level of experienced state mastery-approach. Perhaps given the inherent learning nature of the task, those in the performance-approach condition also deemed it relevant to report being high on state mastery-approach items given the also inherent learning nature of the items. Or, those in the performance-approach condition simply experienced a sense of trying to master the task. This will be addressed in more detail in the discussion section of this chapter.

Preliminary Analyses

Descriptive statistics for all variables by experimental condition are presented in table 6.2. Correlations between task block accuracies and key study variables are also presented in table 6.3. No effect of gender or age on task performance was found (*all p*'s > .40), and experimental groups didn't significantly differ on trait mastery-approach ($p = .93$) or trait performance-approach ($p = .85$), OSPAN scores ($p = .71$), or state-anxiety ($p = .23$). Thus, it seems unlikely that any group differences could be

Table 6.2. Means and Standard Deviations for Study 5 Variables by Condition

	Mastery-Approach		Performance-Approach	
	M	*SD*	*M*	*SD*
Trait Mastery-Approach	12.46	2.72	12.40	2.19
Trait Performance-Approach	11.00	2.57	11.64	2.71
Working Memory Capacity	19.58	11.10	20.80	11.97
State Mastery-Approach	13.50	2.90	13.24	3.96
State Performance-Approach	8.96	2.90	14.68	3.99
Goal Commitment	20.83	3.32	20.48	3.11
State-Anxiety	35.33	7.69	38.40	9.93
Block 1 Accuracy	67.33	11.02	66.72	11.41
Block 2 Accuracy	72.50	10.04	74.52	11.14
Block 3 Accuracy	77.54	7.29	78.60	11.55
Block 4 Accuracy	78.96	8.71	82.72	7.71

Note: Mastery-Approach, N= 24; Performance-Approach, N= 25. Block accuracy is in %.

explained by these variables. To assess whether these non-significant results were due to a lack of statistical power, a series of post hoc power analyses were conducted using GPower software (Faul, et al., 2009) with power (1 - β) set as 0.80. These revealed that total sample size would have to increase by between 82 to 8726, in order for group differences to reach satistical significance at the .05 level. However, for state-anxiety specifically, the sample size would only need to increase by 6 in order for group differences to reach significance at the .05 level. Thus there is some indication that this non-significant finding for state-anxiety can be attributed to a limited sample size. Additionally, both trait goal orientation variables, and post-task self-reported state mastery-approach and self-reported state performance-approach, were not significantly correlated with OSPAN scores (all *p*'s > .50), or state anxiety

Table 6.3. Intercorrelations Among Key Study 5 Variables

	1	2	3	4	5	6	7	8	9	10	11
1. Block 1 Accuracy	-										
2. Block 2 Accuracy.	.62**	-									
3. Block 3 Accuracy	.43**	.84**	-								
4. Block 4 Accuracy	.45**	.66**	.68**	-							
5. Trait Mastery-Approach	-.03	-.29*	-.26	-.33*	-						
6. Trait Performance-Approach	.10	.13	.10	.08	.20	-					
7. State Mastery-Approach	-.10	-.07	-.09	-.17	.42**	.11	-				
8. State Performance-Approach	.09	.32*	.18	.38**	-.07	.36*	-.04	-			
9. Working Memory Capacity	-.05	-.09	-.05	.10	-.10	.07	.03	.04	-		
10. State-Anxiety	-.19	-.24	-.31*	-.06	.23	.06	-.07	.20	.22	-	
11. Goal Commitment	.20	.38**	.48**	.44**	-.04	.05	.06	.05	.06	-.23	-

*Note: *p<.05 **p<.01.*

scores (all *p*'s > .11). Although not significant as just noted, trait mastery-approach did share a modest correlation with state-anxiety (r = .23, p > .05) (see table 6.3). Nineteen participants (38.8%) met or exceeded the performance criterion of 85% on the last information-integration task block. Trait performance-approach shared no relation with task block performance. Regardless of experimental condition, trait mastery-approach was significantly negatively correlated with block 2 (r = -.29, p =.047) and block 4 (r = -.33, p = .021) performance, suggesting that those higher in this trait had poorer accuracy at the mid and end point of the information-integration task in comparison to those lower in trait mastery-approach. To evaluate the role of trait mastery-approach, a median split was applied to trait mastery-approach scores creating a high (n = 25) and low (n = 24) trait mastery-approach group. Mixed design analyses with block as a within-subjects factor and trait mastery-approach group as the between-subject factor, revealed a significant main effect of group, F(1,47) =

4.37, p = .042, and main effect of block, $F(3,47) = 46.21$, $p < .001$. Additionally, there was a significant cubic contrast interaction for block by trait mastery-approach group, $F(1,47) = 4.45$, p = .040. Those high in trait mastery-approach demonstrated more of a cubic trend consisting of two key changes in performance across blocks; an early increase in improvement between block 2 (M = 70.12, SE = 2.01) and 3 (M = 76.00, SE = 1.87) following performance in block 1 (M = 66.32, SE = 2.2), but with performance then levelling off (slowing down) between block 3 (see previous block 3 statistics) and 4 (M = 78.08, SE = 1.58). For those low in trait mastery-approach there was more of a general steady increase in performance across blocks 2 (M = 77.08, SE = 2.05), 3 (M = 80.71, SE = 1.91) and 4 (M = 83.79, SE = 1.61), following block 1 (M = 68.00, SE = 2.29).

State-anxiety scores were found to be significantly negatively correlated with block 3 performance (r = -.31, p =.030), suggesting that overall those who achieved higher accuracies during block 3 were those who reported to have been fairly relaxed during task performance. No correlation between OSPAN scores and task block performance were found (all p's > .50) which will be considered in more detail in the forthcoming discussion section. Given the potential impact of working memory capacity on category-learning, as previously described in the introduction of this chapter, a median split of participants OSPAN scores was also applied creating a low working memory capacity (n = 23) and high working memory capacity (n = 26) group. There was no significant difference between these two groups on category-learning accuracy.

Accuracy Analyses

The number of participants within the mastery-approach and performance-approach condition reaching or surpassing the performance criterion of 85% in each task block is presented in figure 6.2. In the first task block only 2 participants in each condition achieved or exceeded this criterion. In block 2, 12.5% of those in the mastery-approach condition and 28% of those in the performance-approach condition achieved or exceeded the criterion. For the third block, 20.8% of those in the mastery-approach condition and 40% of those in the performance-approach condition. Finally in block 4, 33.3% of those in the mastery-approach condition and 48% of those in the performance-approach condition achieved or exceeded the performance criterion. Based on these percentages, more participants in the performance-approach condition, relative to the mastery-approach condition, were reaching at or above 85% accuracy in block 2, 3 and 4. There was no significant association between meeting or exceeding the criterion of 85% in the final block and goal condition, $\chi^2 = 1.09$, $df = 1$, $p = .30$. Overall, participants that obtained above 90% in the final task block (only achievable by reliance upon the optimal information-integration rule) were all in the assigned performance-approach condition (exactly 16% of those in the performance-approach condition achieved above 90% in the final task block), and this association was significant, $\chi^2 = 4.20$, $df = 1$, $p = .04$.

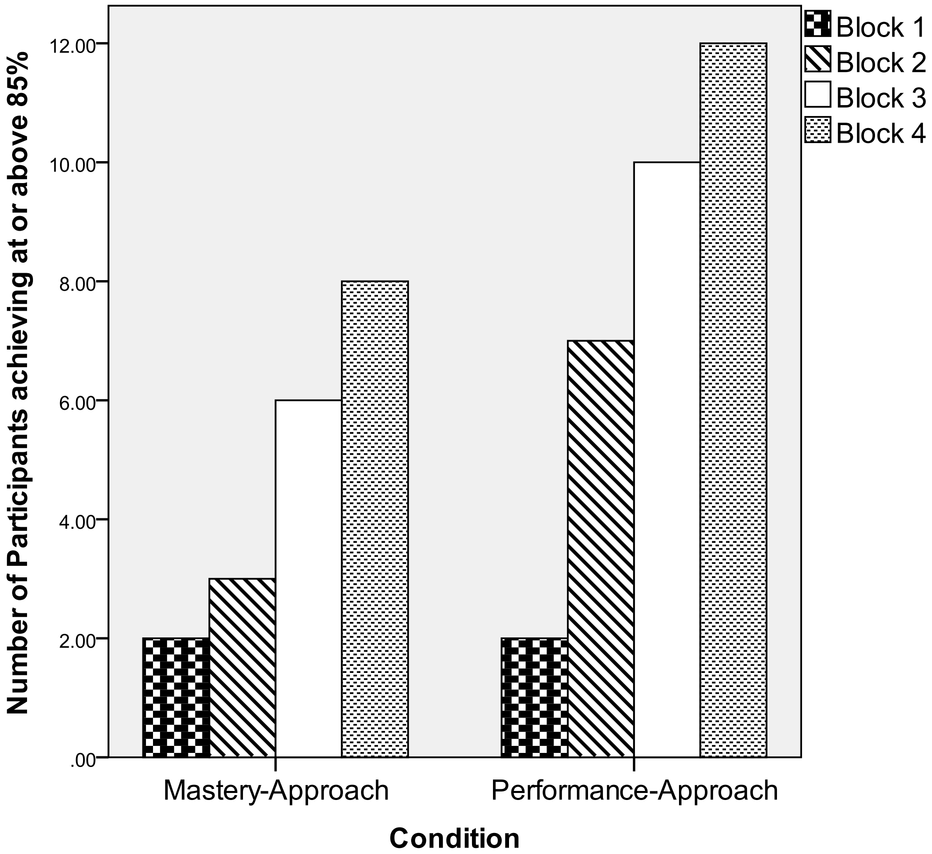

Figure 6.2. Number of participants by condition reaching or surpassing the 85% performance criterion across each block.

The main dependent measure of interest was accuracy (percentages) across the 4 task blocks (see again table 6.2). To explore performance over the task, a 2 (goal condition) x 4 (task block) mixed analysis of variance was run on the accuracy data[27]. There was no main effect of goal group, $F(1,47) = .422$, $p = .519$, but a main effect for task block, $F(3,47) = 45.01$, $p < .001$, indicating a linear trend of increasing accuracy across task blocks for all participants, $F(1,47) = 90.02$, $p < .001$. The pattern of average accuracy percentages across blocks by goal group as presented in table 6.2, illustrates that both goal groups appear to perform fairly consistently in block 1, 2 and

[27] These analyses were run with and without Trait Mastery-Approach scores as a covariate (given this variables correlation with block 2 and 4 accuracy as noted in the preliminary analyses section), and there were no overall differences in the observed pattern of results, thus results are presented without the presence of this variable.

3. Then, in block 4 (final task block), accuracy seems to continue to steadily increase for those in the performance-approach condition, whereas, for those in the mastery-approach condition it seems accuracy slows down. However, no significant interaction between goal group and block was found, $F(3,47) = 1.03$, $p = .380$.

Given that manipulation checks previously discussed revealed a weakness in discriminating the experience of state mastery-approach between experimental groups, it was deemed important to examine whether post-task self-reported state achievement goals offered a different/stronger pattern of results. The interaction between block accuracy x state mastery-approach was non-significant ($p = .840$), however, a significant interaction between block accuracy x state performance-approach was found, $F(1,46) = 10.31$, $p = .002$. Accuracy for each block was regressed separately on all participants' (regardless of condition) self-reported state achievement goal scores. Analyses revealed that although self-reported state mastery-approach shared no relation to accuracy performance on any task block (*all ps* > .24), self-reported state performance-approach positively predicted accuracy on block 2 ($\beta = .741$, $p = .03$) and block 4 ($\beta = .69$, $p =. 007$). Therefore, those who reported post-task to have experienced being in a heightened state of performance-approach during task performance, had higher accuracy at the mid and end point of the task.

To evaluate the role of state performance-approach, a median split was applied to all participants' self-reported performance-approach scores creating a high ($n = 28$) and low ($n = 21$) group. The described block performance pattern of self-reported state performance-approach scores were further confirmed by a significant cubic contrast of the interaction between block and the self-reported performance-approach groups, $F(1,47) = 9.19$, $p = .004$. As shown in figure 6.3, those in the high self-reported performance-approach group, demonstrated less of a cubic trend by showing greater general (linear) progression in accuracy from block 2 (M = 75.00, SE = 1.99), across block 3 (M = 78.40, SE = 1.83) and block 4 (M = 82.80, SE = 1.54), following block 1 accuracy (M = 66.54, SE = 2.12). This reflects more optimal progression, relative to those in the low self-report performance-approach group for whom accuracy seemed to somewhat increase between block 2 (M = 71.61, SE = 2.30) and block 3 (M = 77.77, SE = 2.12) following block 1 (M = 67.67, SE = 2.45) performance, but then accuracy begins to level off between block 3 (see previous block 3 statistics) and block 4 (M = 78.33, SE = 1.77). Interestingly, self-reported state performance-approach adhered to a similar trend as described for trait mastery-approach, however no significant trait-state achievement goal interactions were found across task blocks.

Learning Strategy Modelling

As previously noted, computational models have been developed to determine different types of strategy type that may be adopted during a category-learning task. Specifically, models described by Maddox (1999) and Maddox and Ashby (1993) were applied to the present data in an attempt to determine the strategies most likely employed. Four different types of model were separately applied to each individual participant's data: unidimensional, conjunctive, information-integration, guess. The first model type assumes a simple, unidimensional, explicit rule has been used (i.e., the participant makes their category responses based upon the values of a single stimulus feature – length, orientation or position). This model uses two parameters: criterion placement (i.e., what value on a stimulus dimension distinguishes between

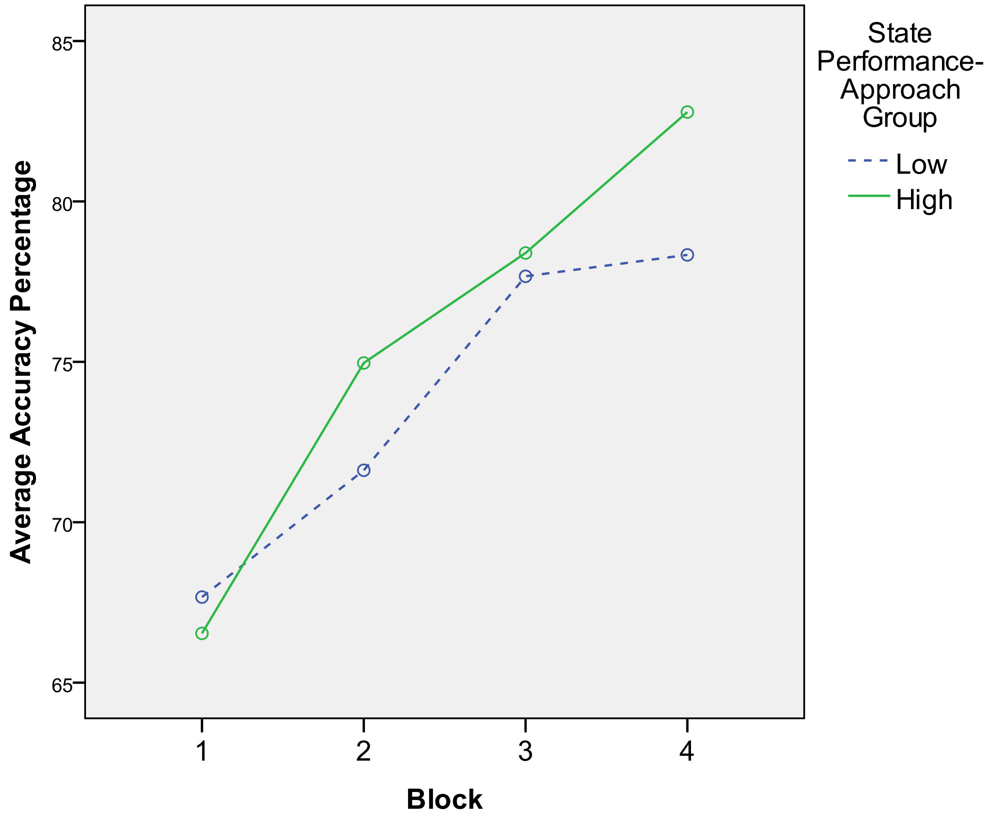

Figure 6.3. Average accuracy per block for low and high self-report state performance-approach groups.

category members) and a noise parameter (that combines perceptual and criteria noise). The most accurate unidimensional rules (with a criterion of 150 units) could obtain approximately 75% accuracy using either the length or orientation dimensions (e.g., for length, if >150 then category = B, otherwise category A. For orientation, the category mapping is reversed - see figure 6.1). The unidimensional rule using the irrelevant horizontal spatial position was also modelled. However, values on this dimension were normally distributed (mean = 150 units) and randomly assigned across categories (hence, maximum accuracy using this strategy = 50%).

The second model assumes a two-dimensional conjunctive explicit rule has been used. This strategy involves making a category judgement after first making separate decisions about the two relevant stimulus dimensions (length and orientation). For example, one conjunctive rule was as follows; if length is above ~116 units and orientation is less than ~186 units, respond category = B, otherwise respond category = A (in other words, if the line was long and shallow, respond B). This model requires three parameters: a criterion for each dimension and a combined noise parameter. The values of the decision criteria above (i.e., 116 & 186) represent the most accurate conjunctive rule that could obtain approximately 86% accuracy. An alternative, equally accurate conjunctive rule (if the line was short and steep, respond A) was also fitted to the data[28].

The third model assumes an (implicit) information-integration strategy has been adopted, whereby information from the two relevant stimulus dimensions is combined before deriving a response. This model type represented the optimal strategy on the task, reflecting the nature of the category structure (i.e., if orientation > length then respond category = A, otherwise category B). This model requires three parameters, representing the slope and intercept of the decision bound (see figure 6.1) and a noise parameter. Using the optimal information-integration strategy it was possible to obtain an accuracy of 95% on the task.

The fourth model assumes that a participant has responded randomly, a guessing strategy (response not affected by any of the stimuli dimensions). This model required a single parameter that captured the probability of responding category A on any given trial. The four models were applied to individual participant's responses, separately for each block of the task. Maximum likelihood methods were used to estimate the parameters for each model and derive a likelihood of that model given the data (i.e., the participant's category responses). Bayesian

[28] Conjunctive rule models using the irrelevant dimension - position - were also fitted to the data. As expected - with position being irrelevant to category membership - these models did not fit the data well and so are not presented.

Table 6.4. Percentage of participants by experimental condition whose data were best fit by each model per block.

Model	Mastery-Approach Condition	Performance-Approach Condition
Block 1		
Unidimensional	45.8%	56%
Conjunctive	29.2%	8%
Information-integration	-	24%
Guessing	25%	12%
Block 2		
Unidimensional	33.3%	20%
Conjunctive	33.3%	36%
Information-integration	25%	36%
Guessing	8.3%	8%
Block 3		
Unidimensional	12.5%	8%
Conjunctive	33.3%	36%
Information-integration	54.2%	52%
Guessing	-	4%
Block 4		
Unidimensional	25%	8%
Conjunctive	33.3%	48%
Information-integration	41.7%	44%
Guessing	-	-

Note: Dashes indicate that percentage could not be computed because no participant's data were classified by this model.

Information Criteria (BIC) (Schwarz, 1978) comparisons were then used to determine the model that best described data, i.e., the most likely strategy adopted by the participant in each block.

For all conditions, a unidimensional strategy was the best fitting model during block 1 with 51% of participants adopting this strategy. In block 2, a conjunctive strategy was the best fitting model with 34.7% of participants adopting this strategy. In block 3 and block 4, an information-integration strategy was the best fitting model with 53.1% and 42.9% adopting this strategy in these blocks respectively. For all participants, those using the optimal information-integration strategy by the final task block performed significantly better in block 4 than those who were using any other alternative strategy in this final task block ($p < .001$). OSPAN scores shared no significant relation with strategy use across the task blocks, suggesting that working memory capacity didn't explain any variation in learning strategies adopted. Again, these results will be considered in more detail in the discussion section of this chapter.

Modelling confirmed accuracy analyses for experimental goal group (see table 6.4). Within the final task block, for 41.7% of those in the mastery-approach condition, and for 44% of those in the performance-approach condition, data was best fit with the optimal information-integration strategy model, suggesting that a slightly higher percentage of those in the assigned performance-approach condition were using the optimal rule in the final task block. However, no significant relations between goal groups and strategy use across any of the task blocks were found (all *p*'s > .26).

Given the observed pattern of accuracy findings for trait mastery-approach and self-reported state performance-approach, modelled response strategies were considered for these variables also. Table 6.5 shows the best fitting models, separately by each block, for low and high trait mastery-approach and self-reported state performance-approach groups. A series of multinomial logistic regression analyses were run using trait mastery-approach and self-reported state performance-approach as continuous predictors and the four model types as the dependent variable (separately for each block of trials). No significant effects were found for block 3. For block 1, analyses revealed a significant main effects model, $\chi^2 = 16.03$, $p = .01$, but only state performance-approach contributed to the model, $\chi^2 = 12.43$, $p = .01$. For each unit increase in state performance-approach an odds ratio of 1.50 was found for the use of an information-integration strategy relative to a unidimensional strategy (CI_{95}, 1.08 - 2.01) (with a unidimensional strategy being the most likely block 1

Table 6.5. Percentage of participants in the trait mastery-approach and self-report state performance-approach low and high groups whose data were best fit by each model per block.

	Trait Mastery-Approach		State Performance-Approach	
	Low	High	Low	High
Model				
Block 1				
Unidimensional	54.2%	48%	61.9%	42.9%
Conjunctive	8.3%	28%	23.8%	14.3%
Information-integration	16.7%	8%	-	21.4%
Guessing	20.8%	16%	14.3%	21.4%
Block 2				
Unidimensional	20.8%	32%	42.9%	14.3%
Conjunctive	29.2%	40%	28.6%	39.3%
Information-integration	50%	12%	23.8%	35.7%
Guessing	-	16%	4.8%	10.7%
Block 3				
Unidimensional	4.2%	16%	14.3%	7.1%
Conjunctive	33.3%	36%	42.9%	28.6%
Information-integration	62.5%	44%	42.9%	60.7%
Guessing	-	4%	-	3.6%
Block 4				
Unidimensional	4.2%	28%	28.6%	7.1%
Conjunctive	41.7%	40%	38.1%	42.9%
Information-integration	54.2%	32%	33.3%	50%
Guessing	-	-	-	-

Note: Dashes indicate that percentage could not be computed because no participant's data were classified by this model.

strategy, according to COVIS, and as supported in the current study by being the best fitting model for all participant data as described earlier). For block 2, analyses also revealed a significant main effects model, $\chi^2 = 22.53$, $p = .001$, with only trait mastery-approach contributing to the model, $\chi^2 = 16.37$, $p = .001$. Trait mastery-approach was related to a decreased likelihood of using the optimal information-integration strategy relative to a conjunctive strategy (conjunctive strategy being the best fitting model for all participants' data in block 2). For each unit increase in trait mastery-approach the odds of using a conjunctive strategy relative to an information-integration strategy nearly doubled (1.70; CI_{95}, 1.15 - 2.42). Finally for block 4, analyses again revealed a significant main effects model, $\chi^2 = 10.90$, $p = .03$. State performance-approach contributed to the model, $\chi^2 = 5.72$, $p = .05$, with the contribution of trait mastery-approach failing to reach statistical significance, $\chi^2 = 5.30$, $p = .07$. For each unit increase in state performance-approach an odds ratio of 1.32 was found for the use of the optimal information-integration strategy relative to a unidimensional strategy ($CI_{95,}$ 1.02 - 1.71). In contrast, trait mastery-approach was related to a decreased likelihood of using the optimal information-integration strategy in the final task block. An increase of 1.6 for each unit increase in trait mastery-approach was observed for the use of a unidimensional strategy relative to the information-integration strategy ($CI_{95,}$ .97 - 2.73). However, the 95% confidence interval for this odds ratio spanned 1 and therefore didn't reach significance.

To determine the decreased likelihood of using the optimal information-integration strategy in the final task block for those higher in trait mastery-approach, the extent to which a participant was using an information-integration strategy (coded as 1) or was using any other strategy (coded as 0) in block 4 was considered. Analyses revealed that the group of participants whose data was best fit by an information-integration strategy in block 4 relative to those whose data was best fit by any other strategy were, albeit marginally, significantly lower in trait mastery-approach, $t(47) = 1.95$, $p = .058$. This suggests that those higher in trait mastery-approach were less likely to be using the optimal information-integration strategy by the end of the task in comparison to those lower in trait mastery-approach.

To confirm whether trait mastery-approach and state performance-approach were related to quicker engagement of the procedural learning system (i.e., quicker to adopt an information-integration strategy), a variable was created which coded the first task block in which an information-integration rule was used. This variable ranged from 1 to 5, with 5 being assigned to participants for whom reliance upon an information-integration rule was not evident in any task block. Trait mastery-approach was positively correlated with this variable (r = .38, p = .007), suggesting that those higher in this trait were more likely to use an information-integration strategy at a later stage of the task. State performance-approach was negatively correlated with this variable (r = -.30, p = .034), suggesting that those higher in this state were more likely to use an information-integration strategy earlier in the task. Analyses of this variable for low and high trait and state groups revealed that the low trait mastery-approach group (by 2.2 mean blocks) were quicker at using an information-integration strategy relative to the high trait mastery-approach group (by 2.9 mean blocks), p = .031. However, no significant differences on this variable were observed between the high state performance-approach group (by 2.3 mean blocks) and low state performance-approach group (by 2.7 mean blocks), p = .16.

Discussion

The present study examined the influence of achievement goal states on a category-learning task for which optimal performance is thought to be hindered by intensive reliance on working memory. Overall, a general linear trend of improving accuracy rates across the task for all participants was observed with the percentage of participants relying upon information-integration rules gradually increasing across task blocks (with the percentage of participants simply guessing decreasing across task blocks) suggesting that participants attempted to modify their strategy as the task progressed. Additionally, those ultimately using an information-integration strategy in the final task block demonstrated the most superior accuracy performance, confirming that more optimal performance was dependent upon an information-integration strategy.

Unfortunately, manipulation checks revealed some failure in differentiating between induced mastery-approach and performance-approach goal pursuit. This may account for why experimentally manipulated mastery-approach and performance-approach state groups didn't differ in performance across the category-learning task. As such, groups also did not differ in terms of modelled learning strategies. Although on average those assigned to the performance-approach condition were reaching higher accuracy percentages in blocks 2 to 4 relative to those in the mastery-approach condition, these differences didn't reach statistical significance. The only significant effect to emerge was an association between being in the assigned performance-approach condition and achieving above 90% in the final task block. This is an important finding, given that optimally achieving above 90% is suggested to only be possible through less of a working memory intensive strategy (information-integration strategy). Thus, results provide some indication for optimal learning, on a task for which less reliance on working memory is advantageous, amongst those assigned a performance-approach goal.

The pattern of modelling results for goal groups do suggest that those in the performance-approach condition were quicker to engage an information-integration strategy, with 24% of participant data in the this condition being best fit by this implicit model relative to no participants in the mastery-approach condition. Also in block 1, reliance upon a conjunctive rule was more evident amongst those in the mastery-approach condition (29.2%) relative to those in the performance-approach condition (8%). Yet, in blocks 2 and 3 the percentage of participants using an information-integration strategy was very similar across the two goal conditions.

Interestingly, those in the mastery-approach condition particularly evidence an increased use of unidimensional rule testing from block 3 to block 4. It seems that some of those in the mastery-approach condition therefore seem to divert somewhat from the optimal task strategy to a more simple explicit strategy right at the end of the task. It is difficult to fully understand why this might be the case. It is possible that a tendency for this goal state to engage working memory encouraged these participants to distract from an implicit strategy back to more explicit rule testing. Perhaps 'settling' on strategies between these goal groups would have occurred more strongly if additional task blocks were used. The use of only 4 task blocks in the current study is towards the lower end in terms of the number of task blocks employed by other researchers (e.g., Filoteo et al, 2010). Thus future research would perhaps benefit from exploring these goal effects across more extended category-learning tasks.

A key explanation for a lack of goal group effects is the possibility that the inherent nature of the manipulated 'achievement goal frameworks' between groups was perhaps not very effective. Manipulation checks revealed that participants correctly recalled and understood their assigned task purpose and achievement goal framework. This suggests that there wasn't any particular issues with participants misinterpreting the experimental manipulations, importantly not one participant in either goal condition ticked the option of *'I was assigned no goal*' or '*I did not understand the goal assigned to me*'. This increases confidence that manipulations were received as intended. Rather, what Goal State manipulation checks revealed is that although those in the assigned performance-approach condition significantly reported to have had a heightened experienced of being in such a state of performance-approach relative to those in the mastery-approach condition, those in the mastery-approach condition didn't significantly experienced being in a heightened state of mastery-approach relative to those in the performance-approach condition. In fact, self-reported state mastery-approach scores show that participants in both conditions had scored high on state mastery-approach items. Thus, those in the mastery-approach condition did report a high state of mastery-approach, however, performance-approach condition participants did also.

It is imperative to note that the overall lack of between groups effects are unlikely to be due to confounds in the adoption of both unidimensional and information-integration rules on behalf of those participants in the assigned performance-approach condition. Predictions outlined that pursuit of a state performance-approach goal would lead to either 1) very limited task performance due to reliance on simple explicit rules, or 2) optimal task performance due to quicker abandonment of the explicit system in favour of the procedural system - with the caveat being here that if participants in this condition vary somewhat in either of these, then, combined effects may lead to no association with task performance. However, modelling results presented in table 6.4 for those in the performance-approach condition suggest little evidence of such bias.

The setting of a challenging target of 85% in both experimental conditions may have also contributed to observed findings. That is, both goal groups were aiming to achieve a high target of 85% accuracy by the final task block. Although this high target was deemed necessary for between goal effects to emerge, it is also possible that such a high target actually resulted in both goal conditions having to apply more working memory than actually hoped. This is consistent to some extent with the propositions of COVIS (Ashby et al., 1998), whereby high targets actually increase the chance of prolonged working memory engagement. This might explain why both goal conditions evidence explicit rule testing throughout the task (see table

6.4). This raises some concern in terms of perceptions of the high target of 85% perhaps confounding the emergence of achievement goal accuracy differences. The fact that post task goal commitment measures confirm strong adherence and belief in the goals assigned amongst those participants in both conditions but no between group effects were identified, could arguably be interpreted as a strong commitment to attempting to achieve '85%' and as such the achievement goal framework surrounding that numerical target may have actually had less of an impact. Future research would benefit from exploring variations in the numerical value of such a target set to see if any different results prevail, i.e., to test whether high targets do in fact confound such between groups effects.

It is possible that the pattern of results observed can also be explained by the inherent 'learning' nature of the discovering rules in the information-integration task which contrasts to the working memory tasks employed throughout the studies in chapters 3 to 5. The present study is the first in the current thesis to consider possible working memory related effects of these achievement goal states within an actual learning context. That is, in the standard task instructions all participants are informed that they were required to categorise and would be given corrective feedback. Although there was no explicit inclusion of words such a 'learn' or 'master' in these standard instructions, it would have been clear to participants that they will be attempting to 'discover' correct categories. This is in contrast to instructions provided in the studies presented in chapters 3 to 5 in which the 'rules of the task' were known and participants just had to focus on performing well. It is possible that this could have influenced participants in the performance-approach condition by confounding their assigned focus on performing above a normative average, with an underlying reminder that they also needed to develop some competence (i.e., a defining feature of a mastery-approach goal) in detecting categories. This in turn may have limited the extent to which a 'truly' less working memory intensive strategy might have been fostered by performance-approach goal pursuit (i.e., increased the possibility of those in the performance-approach condition to engage working memory more than expected). It is possible that, rather than having had any influence on the experienced state whilst completing the task, the learning nature of the post-task state mastery-approach items (e.g., *The opportunity to learn new things on this task was important to me)* simply increased the likelihood of those in the performance-approach condition to rate highly on them as a response to how they more generally perceived or found the task.

It is also imperative to consider possible poor reliability in the assumptions that accuracy and strategies can be explained by working memory variability on the current information-integration task. That is, it is possible that working memory dependency differences between goal groups may not have emerged during this task. Such a proposition is firstly encouraged by the fact that no relations between OSPAN scores (working memory capacity) and either accuracy or learning strategies were found. If variability in accuracy on this information-integration task can be accounted for by engagement of working memory resources then, regardless of goal manipulation, a relation between accuracy (and/or strategies) and capacity might have been expected. Although goal instructions may have countered this, it highlights a possible reason for the lack of between group effects.

The literature as presented in the background review of the current chapter clearly outlines strong support for the how the variability in working memory engagement is reflected in category-learning tasks. However, it is essential to bear in mind the concerns raised by some researchers in terms of the 'true' extent to which variability in working memory can account for differential rule-based and information-integration performance. Filoteo et al. (2010) suggest that although it is widely accepted that hypothesis testing is mediated via working memory, it is possible to implicate other executive functions such as shifting of attention when considering the impact of sequential or secondary tasks on information-integration performance for example. Additionally, the concerns with the selective effects of memory load on category-learning performance discussed in the introduction of this chapter (Nosofsky & Kruschke, 2002; Stanton & Nosofsky, 2007) also highlights that weaknesses in the assumed multiple-systems approach behind the current chapter study might have contributed to results. Furthermore, other research published after the commencement of the current study has provided some initial support for the notion that a) working memory resources perhaps don't directly influence strategy adoption (reflected in accuracy performance) but rather predict how well any strategy selected is used (Craig & Lewandowsky, 2011), and b) that such attentional resources have been contrarily found to be integral to both rule-based and information-integration responding (Lewandowsky, 2011). Thus, perhaps unforeseen weaknesses in the category-learning-working memory relationship led to the use of a poor framework in which to consider differential state achievement goal effects. These new findings might explain why responses of those in the mastery-approach condition were still fit well by an information-integration model, based on the assumption that this state promotes engagement of working memory and that working memory is also important for information-integration accuracy. However, if such working memory based assumptions of task performance in the current study were confounded in the ways just described by these new findings, then arguably those in the performance-approach condition should not have achieved the high levels of accuracy. This is based on the assumption that, if this state promotes less of a reliance upon working memory, then either a) the strategy they selected would have not been implemented well, or b) information-integration based learning would not have been as successful. On the basis that some trait and self-reported state achievement goal variables did predict performance in a manner which was consisted with goal state predictions (as discussed below), lack of between group effects are unlikely to reflect flawed hypotheses or choice of task. All things considered it seems most likely that the two goal groups simply didn't engage working memory differentially in the current study, i.e., goal manipulations were not sufficiently powerful to reflect in working memory dependent category-learning differences on the task. It is therefore reasonable to suggest that future research might benefit from exploring alternative methods of manipulating goal states using possible methods not captured in the meta-analysis presented in chapter 2 due to limiting inclusion criteria used, which might exert more identifiable between group effects on category-learning tasks.

Although no experimental group effects emerged in the current study, other important relations were investigated. Trait mastery-approach was found to be negatively related to accuracy on block 2 and 4 of the task, suggesting that those higher in this trait performed more poorly on these blocks. Results further revealed that being higher in trait mastery-approach increased the odds of using a conjunctive explicit strategy relative to an information-integration strategy in block 2. Also, being higher in trait mastery-approach also increased the odds of using a unidimensional strategy relative to an information-integration strategy in block 4. These results suggest that those high in trait mastery-approach were more likely to be using a working memory dependent strategy at this key task stage. In fact, results further confirmed that those participants using a ‘working memory light’ strategy (information-integration) in block 4 (by the end of the task) were significantly lower in trait mastery-approach.

Exploration of high and low trait mastery-approach groups suggested that accuracy performance of those low in this trait followed more of a general linear improvement across blocks 2 to 4 (i.e., demonstrating more optimal progression across blocks 2 to 4), relative to those high in this trait who demonstrated more of a cubic trend by which there was a 'jump' in accuracy between blocks 2 and 3, but then accuracy levelled off again towards the end of the task. Interestingly, this was further confirmed by findings which show that those in the low trait mastery-approach group were significantly quicker to use an information-integration strategy on average by 2 task blocks, whereas those in the high trait group on average were more likely to be using an information-integration strategy on average by 3 task blocks.

Overall, those who report a typically strong motivational focus on developing ones own skill were slower to successfully engage a less working memory intensive, information-integration strategy. Ultimately results explain why performance didn't progress as optimally (in a linear fashion) for those high in trait mastery-approach as those low in this trait (as also reflected in less superior block 4 accuracy), because the delay in engaging an information-integration strategy possibly meant such implicit rules were still 'being learned'. Importantly, these trait based findings are unlikely to be explained by differences in experienced state anxiety during the task or individual differences in working memory capacity, because as outlined in preliminary analyses, trait mastery-approach was not correlated with these variables. Overall it can be concluded here that a dispositional based motivational focus on developing ones skill seems to hinder the adoption of less working memory intensive strategies, in of explicit, working memory dependent, strategies. This is clearly consistent with the findings for experimentally manipulated mastery-approach presented so far in the current thesis, and with the predictions outlined for experimentally manipulated mastery-approach in the current chapter, but in trait form.

In addition to trait based effects, an interesting pattern of findings was also observed for self-reported state performance-approach. This state variable was found to be positively related to accuracy on block 2 and 4 of the task, suggesting that those reporting to have been in a higher state of performance-approach during the task, relative to those reporting lower experiences of this state during the task, had superior accuracy on these blocks. Modelling results didn't provide clarity on accuracy differences observed for this state variable in block 2, however, results did outline that a heightened experience of state performance-approach increased the odds of using an information-integration strategy relative to a unidimensional strategy in block 1 (although not significantly reflected in block 1 accuracies observed). The same pattern was observed in block 4 for state performance-approach. This suggests that the working memory light strategy fostered by state performance-approach is more likely to be an implicit strategy rather than a simple explicit strategy.

Exploration of high and low self-reported state performance-approach groups suggested that accuracy of those high in this state followed more of a general linear accuracy improvement across blocks 2 to 4 after block 1, relative to those low in this state for which a cubic trend was more evident with a sizeable accuracy improvement between block 2 and 3, but, then accuracy slowed down towards the end of the task (similar trends to trait mastery-approach groups). However, these groups didn't significantly differ in the speed with which an information-integration strategy was employed. Importantly again, these findings for self-reported state performance-approach are unlikely to be explained by differences in experienced state anxiety during the task or individual differences in working memory capacity. The main conclusion to be made here is that by the end of the task, those who report to have been experiencing a heightened state of performance-approach were much more likely to be using the optimal, working memory light, information-integration rule. Again, such findings are also consistent and fitting with the findings for experimentally manipulated performance-approach goal conditions previously reported in this thesis, and with the predictions outlined for experimentally manipulated performance-approach in the current study, but in self-reported performance-approach form. Clearly, being in a state of reported performance-approach pursuit appears to rely less on working memory, specifically reflected in more successful adoption of strategies that are argued to be independent of working memory.

CHAPTER 7

General Discussion

Present Research Purpose

The aim of the current thesis was to contribute to the motivation-cognition interface by examining how qualitatively different approach-based motivational states differentially relate to working memory. The specific achievement goal states of mastery-approach (focus on developing self-referential skill) and performance-approach (focus on demonstrating normative skill) were investigated. These goal states are suggested to form different perceptual-cognitive frameworks, i.e., different patterns of cognition and action, which guide behaviour when in an achievement situation (DeShon & Gillespie, 2005; Dweck & Leggett, 1988; Elliot and Dweck, 1998). Such distinct patterns of cognition and action have been somewhat addressed within the literature in terms as explored in chapter 1, with findings often demonstrating advantages for mastery-approach relative to performance-approach (e.g., Bell & Kozlowski, 2008; Bereby-Meyer & Kaplan, 2005; Elliot, et al., 1999; Escribe & Huet, 2005), but with exceptions (Mangos & Steele-Johnson, 2001; Steele-Johnson, et al., 2000; Winters & Latham, 1996). Overall however, very little work within the literature has examined the cognitive processes elicited by the achievement goal states of mastery-approach and performance-approach. The few attempts by researchers to broadly address possible relations between achievement goals and working memory related performance (e.g., Barker et al., 2002; Graham & Golan, 1991; Linnenbrink et al., 1999; Parkes et al., 1998) have produced mixed findings and clearly suffered from issues relating to experimental and statistical control.

It was hypothesised at the end of chapter 1 that the states of mastery-approach and performance-approach will differentially relate to working memory. The limited research and general ambiguity of research outlined in chapter 1 restricted any specific directional predictions being outlined at the start of this thesis. It was however noted that, given that previous research has not only illustrated that availability of attentional resources influences strategy use (Cokely, et al., 2006; McNamara & Scott, 2001; Turley-Ames & Whitfield, 2003), but also that achievement goals differentially prompt the adoption of cognitive strategies (Elliot, et al., 1999; Fisher & Ford, 1998; Pintrich & Garcia, 1991), progressive investigation beyond gross measures of working memory performance would be sought in attending to the current thesis aim. Specifically, in order to reach some clarity on the achievement goal-working memory relationship, the current thesis set out to include examination of how the role of working memory in achievement goal pursuit might be reflected in task strategies. Finally, a key objective noted in chapter 1, fuelled by the general ambiguity surrounding research which had addressed relations between achievement goals and cognition, was to extend the desired understanding beyond the confounds of weak methodology. That is, prior to specifically attending to the central thesis hypotheses, a meta-analytic review of achievement goal methodology would be conducted in order to allow for more informed designs to be employed in the studies presented in the current thesis.

Summary of Key Findings

The meta-analysis reported in chapter 2 showed, consistent with previous meta-analytic findings (Rawsthrone & Elliot, 1999; Utman, 1997), that study design features influence observed achievement goal effects. Specifically, the method with which achievement goal states are manipulated, the type of manipulation check used, and various study characteristics contribute to variability in manipulation check and task performance effect sizes. The most important finding concerned identifying a combined method of providing a task purpose and an assigned goal frame (e.g., *the* *purpose of this task is to…..as such your goal is to achieve/focus on…..*) as the most effective in producing observable differences between experimental groups. This combined method was found to present the largest manipulation check and task performance effects relative to other methods, with particularly large effects being observed in the case of manipulation checks (Cohen, 1988). As such, this method was identified as the most effective way of successfully manipulating achievement goal states and was employed throughout the experimental studies presented in chapters 3 to 6.

The meta-analysis also reported that use of both a Goal Recall manipulation check (check to confirm participants remembered and understood their assigned experimental condition) and Goal State check (check to confirm whether the desired motivational state was successfully induced), were both found to be effective ways of validating experimental manipulation. Both of these manipulation check types were considered to offer much potential in assessing manipulations throughout the experimental studies presented in chapters 3 to 6. Finally, although study characteristics could explain little variability in task performance effects, a model which addressed the timing of manipulation, delivery method of manipulation, experimenter blindness and timing of a manipulation check type, could partially explain variability in the magnitude of manipulation check effect sizes. Interestingly, the most important study characteristic identified was if participants were asked to read manipulation instructions themselves as a manipulation delivery method, an approach which was consequently strictly adhered to in the current thesis.

Adhering to these meta-analytic findings, the first experiment (presented in chapter 3), provided a preliminary investigation of whether the experimentally manipulated achievement goal states of mastery-approach and performance-approach differentially impact upon working memory processing. It was found that pursuit of a performance-approach goal resulted in poorer working memory processing relative to mastery-approach goal pursuit and pursuit of no-goal (control). Consistent with some previous research (Barker et al., 2002; Graham & Golan, 1991; Wegge et al., 2001), this effect was restricted to the greatest executive load of the N-Back task (3-back), suggesting that achievement goal effects emerge only under the more effortful conditions. Chapter 3 findings confirmed that achievement goal states do influence working memory processing - represented as a possible disruption of working memory when in a state of performance-approach. This arguably provided some explanatory ground for previously observed relations within the literature between a performance-approach focus and less effective cognitive strategy use, as well as for why superior performance for this motivational focus is often limited to the less cognitively demanding situation (Bereby-Meyer & Kaplan, 2005; Escribe & Huet, 2005; Mangos & Steele-Johnson, 2001; Steele-Johnson et al., 2000; Winters & Latham, 1996).

The second experiment (presented in chapter 4) examined the influence of a secondary working memory task, varying in load, on a primary achievement goal pursuit task in establishing the extent to which mastery-approach and performance-approach goal pursuit relies upon working memory resources. Results revealed that all experimental groups experienced some primary task decline from low to high secondary load, but the most substantial decline was evident under pursuit of a mastery-approach goal, relative to pursuit of a performance-approach goal and no-goal control. It was concluded that working memory plays a more vital role in the pursuit of a mastery-approach goal relative to a performance-approach goal. Chapter 4 findings therefore provided further support for the core thesis hypotheses outlined in chapter 1, regarding the potential differential role of working memory in achievement goal pursuit. These experimental results complement the findings from the first experiment presented in chapter 3, by arguably illustrating that superior working memory performance under high executive load for mastery-approach goal pursuit is likely to be due to heavy reliance on/engagement of, working memory resources to order to perform well.

In the third experiment (presented in chapter 5), using a similar dual-task design to that of the second experiment, a primary goal pursuit task known to vary in working memory intensity was utilised. It was predicted that if mastery-approach goal pursuit relies more on working memory resources for successful goal pursuit then under low secondary load such pursuit should demonstrate a particular advantage (relative to performance-approach pursuit, if such pursuit engages working memory less) on parts of the primary task which require such resources. However, this advantage for mastery-approach on working memory intensive parts of a primary task should disappear under high secondary load, as high load should consume the resources typically demanded for successful mastery-approach pursuit. It was proposed that this would be reflected by a substantial decline in performance from low to high secondary load on parts of a primary task which are working memory intensive for mastery-approach pursuit but not for performance-approach pursuit. Results confirmed these predictions. Self-reported strategy use was also measured in this third experiment in order to shed further light on any performance effects. It was predicted that if mastery-approach pursuit relies more on working memory, such goal pursuit is also more likely to prompt a rule-based (step-by-step solving) task strategy which would give such goal pursuit an advantage on challenging parts of a task which demand working memory under low load. However, under high secondary load this advantage would disappear as load would consume resources necessary for a rule-based approach. On the other hand, it was predicted that if performance-approach pursuit relies less on working memory then such goal pursuit should more readily engage a more associative based (short-cut solving) task strategy. Such a strategy would limit performance on challenging parts of a task which demand working memory under low load relative to mastery-approach (on the basis that associatively derived answers don't permit as superior primary task accuracy as rule-based approaches), but this goal pursuit would then be much less susceptible to experiencing a decline in performance under high load (because of its tendency to opt for less demanding strategies when working memory demands are high). Again, results supported these predictions. An important conclusion reached from these findings was that when the resources necessary for superior performance of mastery-approach goal pursuit in effortful conditions are consumed, individuals in this goal continue to rely upon a working memory intensive approach.

Finally, in the fourth experiment (presented in chapter 6) it was predicted that if mastery-approach and performance-approach pursuit differentially engage working memory that this would reflect in differences in gross measures of accuracy on an information-integration task. Unfortunately, manipulation checks revealed some failure in differentiating between induced mastery-approach and performance-approach goal pursuit. This may account for why experimentally manipulated mastery-approach and performance-approach state groups did not perform differently across the category-learning task. Despite this, it was found that both trait mastery-approach and self-reported state performance-approach shared distinct patterns of relations to information-integration performance. Those high in trait mastery-approach were slower to successfully engage a (less working memory intensive) information-integration strategy relative to those low in trait mastery-approach. Similarly, those higher in self-reported performance-approach were more likely to be relying on a working memory 'light' task strategy at the end of the information-integration task relative to those lower in self-reported performance-approach.

Summary and Interpretation

The research findings of this thesis provides at least moderate evidence that achievement motivation does relate to working memory. This series of studies presented outlines that availability of working memory appears to be more important for successful mastery-approach goal pursuit relative to performance-approach pursuit. Specifically, on working memory intensive tasks (e.g., 3-back condition in chapter 3, and high demand problem statements under low load in chapter 5), mastery-approach pursuit demonstrates superior performance relative to performance-approach pursuit. This suggests that mastery-approach pursuit prompts *fuller* engagement of working memory. When secondary load consumes working memory resources available for a primary task in which working memory can be differentially engaged for achievement, mastery-approach pursuit seems to suffer more relative to performance-approach pursuit (chapter 4). Again, this suggests that this goal state prompts more engagement of working memory. Further investigation outlines that this 'fuller engagement' of working memory by mastery-approach goal pursuit is illustrated by reliance upon more working memory intensive, rule-based, task strategies, which are adopted even when resources might not be readily available to support them (chapter 5). Whereas, performance-approach pursuit suffers less when working memory resources are consumed (or performs more optimally when successful task performance requires little engagement of working memory) due to its reliance upon more short-cut, less working memory demanding, associative task strategies (as found in chapter 5; but also partially supported in chapter 6 for a self-reported state form of performance-approach whereby those high in state performance-approach were more likely to be using an implicit, working memory light, strategy). The current research thesis has therefore shown that working memory does play some role in achievement goal pursuit, and that this role is different for a motivational focus on developing self-referential skill relative to a focus on demonstrating normative skill. Similar to the impact of other approach and positive affective states on attention (e.g., Gable & Harmon-Jones, 2008; Gasper, 2004; Gray, 2001; Phillips et al., 2002), these achievement goal states therefore hold much value in terms of understanding the role of motivation in allocating or engaging cognitive resources. The work presented in the current thesis has arguably put forward a clear case that this area of research is fruitful and deserves (demands) continued investigation.

To restate Baddeley's (2007) words outlined in chapter 1, "*the development of cognitive psychology as an information-processing discipline has been hugely productive....... If we are to continue to advance, it is clearly important to go beyond cognition and try to understand not only how behaviour is controlled, but why."* [p. 348]. Clearly, current thesis findings confirm the importance of Baddeley's (2007) concern with the need to progress beyond just cognition in an attempt develop a clearer understanding of why behaviour is controlled.

Research Strengths

Although various strengths have been considered in the discussion sections of each thesis chapter in turn, which were critically contemplated and implicated progressively in study designs, it is necessary to also consider some more broad points of interest in this final thesis chapter. The current thesis has exhibited a number of strengths differentiating it particularly from other investigations of the achievement goal-cognition relationship within the literature. First, a key advantage is the consistency with which the states of mastery-approach and performance-approach have been handled throughout the thesis. A common criticism within the achievement goal approach literature is the long-term struggle to assess achievement goals in a conceptually rigorous manner (Elliot & Murayama, 2008). Various operationalisations of achievement goals across related studies are evident (Deshon & Gillespie, 2005) which holds major implications for interpretation of findings and generalisability across studies. These issues don't go unnoticed as such, but tend just to be acknowledged in discussions as areas for future research. The work presented currently however adhered to very tight, evidence based, methodology surrounding the manipulation and assessment of goal states.

Second, previous research reviewed in chapter 1 can be criticised for keeping investigation at a very subjective level, with much research examining the connectivity between achievement goals and 'typically engaged' cognitive strategies (e.g., *In general....* "*To learn the material from my course, I rehearse the important material until I know it*", Wolters, 2004). Research presented in the current thesis moves this on somewhat to not only examining more specific forms of cognition more impartially, i.e., working memory processing, but also attempted to base investigation of working memory related task strategies objectively within the framework of an associated experimental task.

Third, research presented within the current thesis is the first investigation of the achievement goal-working memory relationship which has consistently accounted for a variety of associated nuisance variables, and conducted rigorous manipulation checks of motivational states. Very little previous research has attempted to account for trait goal orientation when examining state effects despite there being clear evidence of the influence of such traits on state based cognitive performance (e.g., Chen & Mathieu, 2008). Given that none of these nuisance variables were able to explain observed between goal condition effects, the work presented in this thesis engenders greater confidence in the role of working memory in achievement goal pursuit than previous research discussed in chapter 1. Although these nuisance variables and checks have been discussed in some detail throughout chapter 2 and 3, some more attention to the role of state-anxiety is particularly worthy of mention here. Researchers have been interested in understanding whether, and how, anxiety might play a role in achievement motivation. Some have suggested that a performance-approach focus fosters heightened anxiety relative to mastery-approach (Chen, et al., 2000; Linnenbrink et al., 1999), due to it's 'other' comparative nature. However, others have found little or weak relations between anxiety and performance-approach (Wolter et al., 1996; Middleton & Midgley, 1997; Skaalvik, 1997). Amongst those who have specifically addressed the achievement goal-working memory relationship, anxiety has often been of interest. Some have found that performance-approach only relates to working memory when negative affect is accounted for, or only amongst those participants low in trait anxiety (Huijun et al., 2006; Linnenbrink et al., 1999). It has been argued that such findings indicate differential allocation of cognitive resources between achievement goal states because performance-approach states specifically direct attention to more anxious thoughts and concerns that undermine effective use of cognitive resources. Whereas, mastery-approach states direct more attention towards the task and thus less anxious thoughts (DiCintio & Parkes, 1997;

Linnenbrink et al., 1999; Parkes et al., 1998). However such research has only been based upon trait or self-reported forms of achievement goals; no research had confirmed such effects with experimentally manipulated goal states. Thus, although researchers have speculated on the basis of all these findings that the consistently observed poor relation of performance-approach to cognition is likely to be explained by anxiety or worry, there is little empirical research to actually support this projection. The work presented in the current thesis didn't find any support for the role of state-anxiety in the differential relations of achievement goal pursuit with working memory.

Finally, addressing the achievement goal-working memory relationship in this thesis has been achieved using various research approaches, including single and dual task designs, in which optimal performance has been both more and less dependent upon engagement of working memory resources. This has provided a strong test of the core thesis hypotheses, moving beyond set-based working memory span tasks towards a much richer understanding based upon working memory processing. Overall, the consistent addressing of the core thesis hypotheses using reliable manipulation methodology (based on meta-analytic findings) but within different research designs, allowed for some replication of key findings, i.e., that achievement goals do relate to working memory and mastery-approach pursuit appears to rely more on such resources relative to performance-approach pursuit. Taken together, these strengths constitute a strong and novel research investigation.

Research Limitations

There are some noteworthy concerns which might have influenced the findings in this thesis. In addition to those limitations discussed throughout the thesis, one concern that needs highlighting in the possible influence that completion of a trait goal orientation measure might have had on then effectively inducing state achievement goals within the same experimental testing session. In all of the studies presented in chapters 3 to 6, participants completed trait measures at the start of each testing session before receiving state manipulations later in the same session. It is difficult to determine the extent to which items completed in the trait measure might have either a) influenced the participants situational focus which might have made the then experimentally manipulated state harder or easier to induce depending upon compatibility with the situational focus adopted, or b) might have made the objectives of the state based experimental task more transparent (i.e. examination of varying motivational foci). In fact, it is possible that such awareness may have then also influenced the completion of state manipulation checks in terms of participants attempting to satisfy experimenter expectancies and the desirability to seem as if one was attending to instructions, rather than actually having experienced an achievement goal state. Either way, progressive work here might like to conduct trait assessment more independent of the testing session, e.g., perhaps online prior to attending a testing session, to see if this has any influence on the pattern of results found in this thesis, particularly to the strength and consistency of manipulation check effects.

In terms of manipulation check effects, although states were found to have been effectively induced in chapters 4 and 5, there was some concern with effective manipulation in both chapter 3 and 6 in terms of Goal State (motivational state) checks. Despite the pattern of manipulation check results in chapter 3 generally confirming the desired manipulation effects, the reported experienced of state performance-approach for those in the assigned performance-approach condition was not significantly higher than that reported by those in the mastery-approach condition.

In contrast, mastery-approach manipulation was found to be weak in chapter 6, with those in the assigned performance-approach condition reporting a similar experience of state mastery-approach to those in the assigned mastery-approach condition. It is not unreasonable to implicate the quality of post-task state manipulation check items here. This is particularly instigated on the basis that although chapter 3 checks didn't significantly differentiate state performance-approach from state mastery-approach, task performance effects appeared to be specifically evident for performance-approach pursuit. Although reliability analyses throughout the thesis outlined no concern with the internal consistencies of the Horvath et al. (2001) scales used as Goal State checks, as noted in the discussion sections of chapter 3 and 6, poor general form and terminology could have limited the strength of these scales. Perhaps the selected goal state check (based on chapter 2, meta-analytic findings) was not the most appropriate or valid standard measure on the 'market', but it was beyond the scope of the current thesis to begin to investigate this variability. Therefore, it is suggested here that further assessment and validation of standard state achievement goal scales is imperative if the use of manipulation checks is to continue to be contributory to the investigation of the achievement goal-working memory relationship.

Future Directions

Investigation of achievement goal effects remained at a between-subjects level of investigation throughout the entire thesis. Previous research has shown that within-subject manipulations of mastery-approach and performance-approach states have been somewhat informative in terms of understanding the interactive effects of these goal states (Durik & Harackiewicz, 2003; Kozlowski & Bell, 2006) which could offer much value to the current research area of interest. Although arguably manipulation methodology for within-subject designs would need to be reconsidered relative to that recommended by meta-analytic findings in chapter 2, it would be ideal to follow up the findings of the current thesis with such designs. By doing so the true extent and reliability of the role of working memory in mastery-approach and performance-approach pursuit can be more thoroughly explored. Furthermore, although reasonable sample sizes were utilised throughout the current thesis, in some cases when analyses were restricted to certain between-group comparisons and/or participants were classified or categorised into groups for temporary analytical interest, smaller or biased sample sizes may have led to insufficient power to detect the full capacity of effects. Therefore, further investigation would benefit much from attempting to replicate the current thesis findings with larger samples. This might be particularly facilitated from the previously noted role of within-subject designs to some extent.

The use of more diverse samples beyond university students would be very beneficial to this research area. For example, investigation of more applied samples in which mastery-approach or performance-approach pursuit is more naturally provoked or dominant would be ideal (i.e., in the classroom or workplace). This is particularly necessary in order for progressive research to establish the extent to which current thesis findings actually hold across different contexts. Possibly, fluctuations in motivational states might be more stable in more meaningful, applied settings and thus such extended investigation would be productive. Interestingly, this would also open up the opportunities to examine the role of working memory from a more applied perspective too, in how such a role might actually be reflected in classroom or workplace activities/performance. Furthermore, all of the tasks examined in the current thesis have been unfamiliar to participants, it would be interesting to see, consistent with the explicit monitoring hypothesis (Baumeister, 1984) touched upon in chapter 6, if in more applied settings where perhaps tasks varying in attentional demands are more learned or even investigating 'experts', would be particularly insightful in terms of developing the understanding of how a focus on demonstrating skill (performance-approach) might relate to working memory.

The aims of the current thesis have been to fairly directly address the relations of achievement goals to working memory, offering some explanation for previously found patterns of cognition (general cognitive task performance or more dispositional based self-reported cognitive strategy use). For example, although this thesis has been insightful, one really has to still question why mastery-approach pursuit might rely more on working memory. Clearly this motivational focus’s association with persistence and increased effort (Button, et al., 1996; Dweck, 1986; Fisher & Ford, 1998; Meece, et al., 1988) help one to begin to understand the current thesis results, presumably there are still underlying explanatory constructs at play. Those variables suggested by previous researches to play a central role in understanding why achievement goals might relate to cognitive performance, such as ability and anxiety (Kanfer & Ackerman, 1989; Linnenbrink et al., 1999), were not found to play a role in the present thesis findings. Thus, perhaps progressive research needs to look more to other antecedents of achievement goals to begin to understand what motives or needs might fuel the differential relation of achievement goals to working memory. Alternatively perhaps turning to other literatures to fuel continued research would be valuable in terms of considering how mastery-approach pursuit might be compatible or overlap with other states or situations in which there is fuller engagement of working memory resources. For example, considering compatibility with research addressing interference effects and goal-directed control of attention could be particularly insightful here (Kane & Engle, 2000; Lavie & De Fockert, 2005). As noted in the discussion of chapter 5, much research has suggested that when there are more working memory resources available, individuals are better able to focus their attention on selective task properties (Conway et al., 2001; Ricks et al., 2008), however this could make such individuals more susceptible to detecting alternative solutions or approaches. Ricks et al. (2008) specifically found that those high in working memory are less likely to abandon the wrong path in order to find the correct one due to their superior maintenance of attention. Such research could offer some scope in terms of understanding, and thus contributing to continued research design, why mastery-approach pursuit persists with working memory intensives approaches even when resources are limited.

In accordance with research discussed in chapter 1 (Joostman & Koole, 2006), it is possible that achievement goals may actually act as key moderators of working memory resources under various conditions. For example, previous research clearly shows that individuals can convert feelings of pressure or load into feelings of challenge under conditions that potentially jeopardise their self-image (Blascovich & Mendes, 2000). Thus, it could be possible that mastery versus performance goal pursuit mobilise this somehow, alleviating or exaggerating working memory reliance as the situation demand. Investigation therefore of these goal effects under different situational/environmental conditions would be of much future interest.

The current thesis specifically investigated the *approach* forms of a mastery and performance goal focus. Obviously, progressive research attention should be directed at investigating the extent to which the *avoidance* based forms of these goal states might also and indeed differentially, relate to working memory. For example, does mastery-avoid pursuit similarly engage working memory resources alike mastery-approach, or perhaps it is more consistent with performance-approach pursuit? This would make for very interesting developments to the current thesis. Importantly, research does suggest that when pursuing the approach versions of achievement goals it is likely that individuals can shift at points to the avoidance dimensions (Brophy, 2005). This particularly highlights the value of considering interactive effects of achievement goals using within-subject designs within the current research area, but also draws some attention to the fact that given no attempt to measure the state experience of mastery-avoid or performance-avoid in the current thesis was made, these avoidance based foci may have played some, overlooked, role on the between approach based group effects observed in the current thesis. Clearly, extended research is necessary here to shed light on this possible approach-avoidance confound.

A further point to be made is with regards to the very individual nature of the motivational manipulations investigated in the current thesis. Although as stated in chapter 2, the current thesis intention was to manipulate goal states on an individual basis, it doesn't deter from the fact that group based manipulations might also hold some value in broadening the understanding of the achievement goal-working memory relationship. For example, it could be said that manipulating more social structures in inducing performance-approach might increase the magnitude of between group effects, i.e., exaggerate the actual role of working memory here. Interestingly, some have found that manipulating competitive based motivational states in teams rather than individually, has a stronger positive effect on memory (Ngaosuvan, 2004), providing some encouragement for this recommendation.

It would be inappropriate to neglect considering the possibility that the pattern of thesis findings might reflect the fact that one achievement goal might have been perceived as more difficult than the other. Participants in both achievement goal conditions throughout chapters 3 to 6 were completing the exact same task just framed differently with numerical targets used throughout chapters 4 to 6 identical. Yet, no measures of perceived task or goal difficulty to differentiate between conditions was included in the current thesis. For example, heightened perceptions of difficulty here might have contributed to performance-approach poor performance in chapter 3, or heightened perceptions of difficulty might have contributed to mastery-approach experiencing the largest decline from low to high load on a primary task of interest in chapters 4 and 5. Although if there were key differences in perceived difficulty between goal states it would have likely emerged on state-anxiety measures, it would still be beneficial to explore this in future research.

A further general point to be made here is that given the novelty of the core thesis hypotheses, investigation of working memory remained at quite a broad processing level. This was of course the intention of the current thesis, but as pointed out in chapter 1, there exists an extensive amount of research illustrating the important individual roles of working memory components in understanding attention and strategy use (Baddeley, 1996; Baddeley et al., 1998; Phillips et al., 2001), and this could hold much potential in deepening the understanding of the achievement goal-working memory relationship. For example, research which has suggested that maintaining material using the phonological loop is much less attention demanding than doing so within the episodic buffer and visuospatial sketchpad (because these components involve more continued attention, mostly because these systems are more likely to involve unfamiliar material such as novel matrix patterns rather than digits or words which can be regenerated by the process of speech) (Baddeley, 2000) might shed some light on other possible working memory light approaches for performance-approach relative to mastery-approach pursuit.

Research Implications

The findings presented in this thesis have clear theoretical and practical significance. First, findings clearly contribute to the blooming motivation-cognition interface by highlighting that working memory plays a role in achievement goal pursuit. As argued in chapter 1, there is still much to be learned from integrating motivational and cognitive theories and this current thesis clearly confirms such valuable progress. Findings here have shown that considering the working memory model (Baddeley & Hitch, 1974) in a wider theoretical context broadens the understanding of when and where working memory might be more important (Baddeley, 2007).

Second, findings also specifically hold much explanatory power in terms of why achievement goals have often found to relate to distinct patterns of cognitive performance, namely because of differential reliance upon working memory. Working memory is therefore a possible mechanism by which achievement goals relate to cognitive performance/strategy use; although this clearly demands further research attention. The fact that consideration of effects under high executive load have been particularly revealing in the current thesis also provides some insight into why achievement goal effects on cognitive performance are particularly found under more complex task conditions. That is, the influence that differential reliance upon working memory resources between these goal states has, only emerges when demands on working memory are intense. Also, current findings provide insight into why performance-approach pursuit only tends to demonstrate advantages over mastery-approach in less demanding contexts; arguably because reliance upon less working memory intensive strategies would likely only facilitate performance under less demanding conditions relative to what fuller investment of working memory might in such conditions. However, it would be interesting here to further examine this pattern of effects. When resources become limited current thesis results illustrate that performance-approach pursuit continues to prompt more working memory light strategies, but mastery-approach still prompts working memory heavy strategies. How this consistency reflects in actual task performance warrants further investigation though, i.e., could performance-approach actually demonstrate an advantage relative to mastery-approach in more working memory demanding conditions, but when the resources aren't actually available to fulfil task needs? Overall findings therefore refute previous speculation from researchers (Parkes et al., 1998) that achievement goals don't have the power to influence working memory.

Third, the findings presented in chapter two have major implications for the achievement goal literature. These findings offer clear recommendations in terms of the methods used to manipulate goal states, methods used to validate manipulation of goal states, and various study characteristics which should be carefully considered when designing achievement goal research. For example, a method which manipulates participants perceptions of ability (i.e., ability is stable versus ability is changeable) to induce goal states, should now be handled with caution given chapter 2 results. Arguably, chapter 2 findings should work to initiate more consistency with which researchers 'manage' future state achievement goal investigations.

Fourth, the current thesis has highlighted that previously implicated constructs in the achievement goal-cognition relationship might not play as critical a role as initially thought; anxiety in particular. What can be implicated rather, particularly in light of the research discussed in chapter 5 regarding 'choking under pressure' (Beilock & Carr, 2005) and associated thesis findings, is that perhaps researchers should become more open to the possibility that mastery-approach pursuit is more vulnerable to suffering under anxiety given this goal states heightened reliance/dependency upon working memory resources.

Fifth, in showing that achievement motivational foci can shape engagement of working memory resources, work in the current thesis offers much value to researchers interested in developing models of attention which attempt to capture the role of real-world behaviour. These findings for example could contribute much to the development of training performance strategies designed to either minimise or maximise allocation of working memory resources. There might be particular job roles, for example, in which more or less working memory is advantageous and application of mastery-approach and/or performance-approach prompts could be of value. Moreover, these motivational manipulations might offer some scope in alleviating working memory constraints experienced in applied settings. For example, a student finding it difficult to manage a heavy load might benefit from being assigned performance-approach based goals with the aim of assisting them in identifying less demanding strategies to facilitate minimal learning at least. Alternatively, they could be assigned mastery-approach based goals with the aim of facilitating a broader scope of attention to manage a heavy load.

Conclusion

In sum, the present research thesis has broadly shown that working memory plays some role in induced achievement goal pursuit. The availability of working memory appears to be more important for mastery-approach goal pursuit relative to performance-approach goal pursuit. A focus on developing self-referential skill (mastery-approach) relies heavily on working memory for successful goal execution, facilitated by task strategies that place heavy demands on such resources. Conversely , a focus on demonstrating normative skill (performance-approach) depends less on working memory, facilitated by the use of task strategies that place little demand on such resources. That such simple motivational inducements - common in many applied contexts such as the classroom and workplace - influenced working memory processing is an important finding, given the central role of working memory in learning.

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